POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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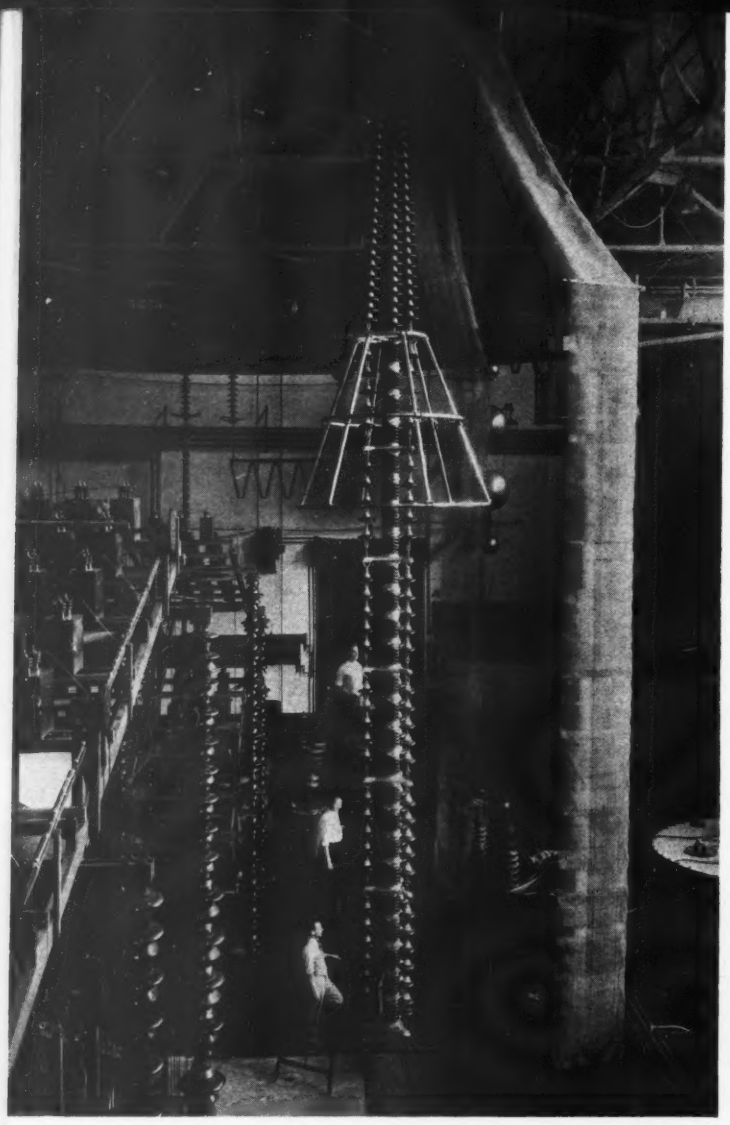
For the Defense *of* Boulder Dam



One of the Giant lightning Arresters for the Boulder Dam line on test at the Pittsfield laboratories of the General Electric Co.

BOULDER DAM is the "biggest" thing man has ever done. It is at once the largest, the most daring and the most spectacular feat of engineering ever undertaken by all the ages of man since the dawn of history. People have journeyed from all parts of the world to see the Pyramids, the Great Wall of China and other of the seven wonders of the world, yet during the past five years there has been erected and practically completed in this country a project which is mightier and more wonderful than any of the classic wonders. For everything connected with Boulder Dam project is of enormous proportions. From the mighty Colorado River itself to the voltage of transmission used nearly every element in its construction is the largest of its kind. New methods and new designs were developed and whole factories had to be built at the plant for the fabrication of material. The largest concrete mixing plant in the world was built at the site. In Los Angeles, the terminus of the 266 mile transmission line, a special cable plant was built for the manufacture of special hollow copper conductor which was developed especially for this line. The line itself carries the highest transmission voltage in the world—275,000 volts. Entirely new types of circuit breakers were developed and constructed to handle the power at this voltage, breakers which have an interrupting rating of two and a half million kv.a. In the photograph above we show one of the giant Thyrite lightning arresters which will protect the lines from lightning. As shown here it is being tested at the General Electric high voltage laboratory at Pittsfield before being shipped. It is rated at 287,000 volts, is 45 ft. high and weighs 4500 lb.

This arrester is typical of the type of development that has characterized almost every phase of the entire Boulder Dam project. Indeed, the engineering problems that have been solved in the design and construction of this development are truly amazing and include almost all branches of engineering, civil, mechanical, structural and electrical. Not the least important was the handling and housing of the thousands of workers. This involved the construction of an entire city, with stores, theaters, transportation and lighting systems, etc., complete. The commissary fed 2800 men three meals a day. At breakfast flap jacks were turned out at the rate of 300 per minute. Even in the setting of the concrete in the great dam, a special system of refrigeration had to be developed and installed to dissipate the heat generated in setting.

All of these matters were handled with remarkable dispatch and efficiency. From the day operations began some five years ago there has never been an interruption in the work. Night and day, continuously, it has proceeded relentlessly so to speak, with strict adherence to schedule and specifications and it will go into operation this year, over a year in advance of schedule.

Much has been said and written about Boulder Dam, many "pros" and "cons" have been offered with regard to its economic or social justification and with respect to its intrinsic value, but regardless of one's prejudices socially, politically, or economically, as an engineering achievement Boulder Dam permits of little criticism. It stands supreme, an outstandingly brilliant achievement of American engineering skill and resourcefulness. Every engineer worthy of the name should take pride in its completion. From an engineering standpoint, the construction of this great project needs no defense.

WITH THE EDITORS

30 Hours a Week?

ADVOCATES of compulsory 30-hr. week legislation advance six major arguments in its favor. They claim as results to be gained, increase in employment, in purchasing power of workers, in consumer demand, in employment security, in flow of private credit and in standard of living and demand for goods and services.

Analyses of the results to be expected have been made by a committee of editors of The Associated Business Papers, Inc., and by the National Industrial Conference Board, Inc., the results of the two studies agreeing in all essential conclusions.

Temporarily some increase in employment might result in some industries but as cost of manufacture, hence of prices of goods, was increased, demand would slacken with consequent loss of work. Inasmuch as reduction of unemployment by N.R.A. codes, which reduced working hours per week from 40 to 34½, was only some 1,800,000, the reduction from 34½ hr. to 30 hr. would not be likely to have any greater effect. Of some 7,000,000 unemployed, the most capable workers are not on relief and these would be the first to be employed, consequently the effect of the 30-hr. week on federal relief expenditure would be negligible.

Those workers who gained employment would have added purchasing power, but those now employed would lose, even at the same weekly wage as now, since the cost of goods would be increased some 10 to 25 per cent, and this increased cost would lessen consumer demand especially for products not in the essential class such as durable goods, thus hurting industries in which unemployment is now greatest. For consumable goods, such as food and clothing, demand would decrease as prices rose, as has been evidenced by various buyers' strikes during the past year.

Employment security depends on a large and continuing demand for goods. If this demand is reduced, due to inability of consumers to buy, or the decreased purchasing power of the incomes of wage earners, salaried workers and farmers, employment security is diminished, because manufacturers cannot continue to make goods that they cannot sell. Employment security depends on the demand for workers being equal to or greater than the supply. Any course which will lessen the market for goods will result in lessened employment security.

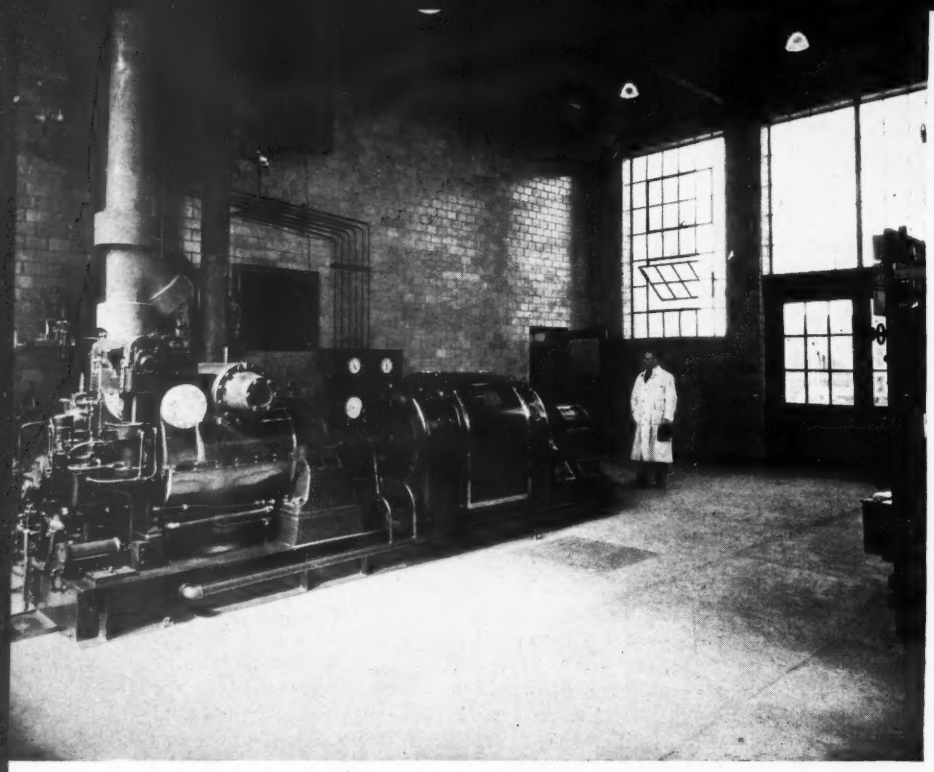
Just what is meant by flow of private credit seems uncertain. More credit is now available than is being used by industry and how increase of available credit is to be brought about by increasing cost of goods so that less of the national income will be left for savings is difficult to follow. Large demand for goods and services depends on large supply at as low price as possible. When price of goods or cost of services is increased, demand decreases correspondingly, since fewer people can afford to purchase or hire.

Standard of living depends upon the quality of food, clothing and housing and on the part of income available for conveniences and luxuries after necessities are provided. With increase in prices, those who have no margin of income above necessities must reduce quantity or quality of those necessities. Those who have had some margin will find it reduced so that their ability to have conveniences and luxuries will be lessened or may disappear. It has not been shown how the standard of living of those now employed and who are helping to furnish relief for the unemployed is to be aided by increasing of costs and prices.

Demand for increase of hourly wages above the present level, as would be necessary if weekly wage is to be maintained with reduced weekly hours, and further increase to maintain purchasing power as prices increase is left by the 30-hr. advocates to be settled by collective bargaining with the strike as the means of enforcement. Possibly some few of the largest and strongest corporations might pass on increased costs to buyers or absorb some part of them, but the greater number of the corporations are still operating with little or no margin of profit or at a loss, hence could not do this. Competition for sales would prevent increase in selling prices, losses would appear or increase and cessation of business would inevitably soon follow, with consequent loss of employment to workers for those companies.

Sentiment of those in responsible positions in industry seems to be solidly adverse to the 30-hr. week. All analyses of probable results point to increased costs, lessened demand, lower standard of living, increased unemployment and slowing up or stopping of industrial recovery, especially in those capital goods industries where unemployment and business depression are worst. Also that neither workers nor employers would benefit from compulsion of a 30-hr. week at this time. Yet, advocates of the 30-hr. law are doing plenty of shouting and have announced an "unalterable and uncompromising" drive for passage of such a law, requiring a 6-hr., 5-day working week. Unless industry makes itself heard by Congress, it is conceivable that such a law may be passed and the resulting bad effects forced upon the country by those who advocate scarcity of food and goods as a means to have everybody have more.

CONVINCING PROOF of the value of student branches of the national engineering societies is offered each year by the Student Conferences of the A.S.M.E. At the third Midwest Conference held in Chicago last month fifteen papers were presented and it is unfortunate that each and every member of the Society could not have been present to see how well these papers were delivered, how capably the discussion was handled and how orderly the meetings were conducted by the student members presiding. The standard maintained was high.



Extraction

View in the new turbine room in the plant of the Rath Packing Company. The turbine is a 625 kw. unit operating at 430 lb. throttle pressure, bleeding steam at 125 lb. and exhausting at 45 lb.

LOCATED AT WATERLOO, IOWA, the Rath Packing Co. prepares high grade ham, bacon, beef and related products from the "land O' Corn." The management is progressive, capital expenditures have been frequent, and continual advances have been made in many branches of the industry. As a consequence of this progressive spirit, the business has developed steadily and several extensions have been made to the power station to keep pace with the increasing demands for steam and electric power.

Packing plant processes use large amounts of steam at moderate and low pressures for drying, cooking, lard rendering, and other purposes, and require considerable power for mechanical conveying equipment and for the operation of ammonia compressors for refrigeration service. Steam and electric power are subordinate in importance to meat packing but nevertheless justify careful attention to maintain low costs.

The new extension to the power station is typical of the modern trend for industrial enterprises. The analysis of the requirements was made by the Stone & Webster Engineering Corporation who also designed the station addition and supervised its construction. The principal objectives in the development were to provide a low capital investment power station which would perform reliably with low operating cost.

Manifestly, there were several practicable developments of the power station which would have met all the physical requirements. The development decided on was along the lines of low capital investment, a boiler unit of fair capacity to operate at moderate pressure, and a turbine generating unit of medium size to produce by-product electric power. Figure 1 shows the general plans and cross section of the power station. It will be seen that the new extension retains symmetry in appearance, both in building structure and boiler equipment as determined by the earlier installations, with basic uniformity in operating features.

The new extension utilizes to advantage existing equipment such as coal and ash handling apparatus, coal storage silos, boiler feedwater heater and hot process softener, also practically all of the existing piping systems. The extension has been planned from a practical viewpoint, starting from conditions as they existed rather than being evolved as an entirely new pattern.

The capacity of the boiler and of the turbine generator was determined after study of the steam and electric power requirements during day and night operation throughout recent years. Figure 2 shows the steam flow diagram and indicates the simplicity of the heat cycle. Steam is extracted from the turbine at a pressure of 125 lb. per sq. in. which is the working pressure in the present steam header. The turbine exhausts at a pressure of 45 lb. per sq. in. to supply steam for many processes in the packing plant. The new boiler is constructed for a working steam pressure of 448 lb. which makes available a satisfactory expansion cycle through the turbine. The auxiliaries for the new boiler installation are operated at 125 lb. pressure which is consistent with obtaining best results in "heat balance."

Automatic control apparatus of the oil relay type is provided with the turbine to maintain the desired extraction and exhaust pressures. The extraction mechanism controls the amount of steam flow into the high pressure end of the turbine by varying the number of steam nozzles in use, thereby enabling the unit to carry a maximum of load in direct proportion to the steam utilized. The back pressure mechanism controls the amount of steam flow to the lower stages of the turbine beyond the extraction point, so as to maintain 45 lb. per sq. in. pressure at the exhaust outlet.

Turbine *and* 448 Lb. Boiler, *Features of New Power Plant at* Rath Packing Company

By MAURICE W. CARTY
Mechanical Engineer, Stone & Webster Eng. Corp.

In planning a new power development any of several practicable arrangements usually will meet the physical requirements. This was true at the Rath Packing Co. but the line of development decided upon was one of low capital investment which at the same time would provide a high degree of operating economy. Since these are the primary requirements of practically all industrial plants, the details of this splendid little plant should be of interest to all industrial power plant operators. The non-condensing extraction type turbine used is of great advantage in maintaining an economical heat balance.

The turbine generator produces electric power as a by-product from the steam on its way from the boilers to the processes for which it is primarily intended. This by-product power is produced with high thermal economy because all the heat not utilized by the turbine for power remains in the extraction and exhaust steam available for process uses. This fortunate characteristic of by-product power permits it to be generated at the low heat consumption of 5500 B.t.u. per kilowatt hour. This heat rate may be compared with 14,000 to 20,000 B.t.u. per kilowatt hour required by steam power stations where the exhaust must be condensed and its heat lost owing to the lack of a suitable use for it.

At the Rath Packing Company the development is carefully balanced so as to obtain the maximum economies possible from by-product power while retaining the stability of central station power for that part of their load in excess of the by-product generation.

In the boiler house simplicity in equipment has been the determining factor and there has been no striving for the highest possible thermal efficiency. The new boiler capacity is about 35,000 lb. of steam per hour and operation is normally at less than 200 per cent manufacturers' rating. The bent tube four drum type boiler with cross baffling was selected because of its moderate cost, adaptability for installation within desirable building dimensions, as determined by existing construction, low draft loss, and liberal steam space. The naturally large furnace volume readily available under such a unit is advantageous.

This type of boiler with reasonable attention to water treatment is less likely to have trouble with scale formation in the tubes than other types, because of rapid circulation up the front tube bank and the large settling out volume in the mud drum. The concentration of salts in the boiler water is kept from rising above predetermined limits by the normal operation of blow-down. The furnace volume is 1200 cu. ft. and the rate of heat release is about 30,000 B.t.u. per cu. ft. per hr., which is conservative for a stoker fired installation of this type. Under these conditions no furnace water walls or air ventilated setting are necessary and low cost solid fire brick walls suffice. Because of the moderate operating rate the exit gas temperatures are reasonably low and no feed water economizer or air preheater was justified. This makes for low capital investment, compactness in arrangement, and, for the planned operation and low price of coal, gives satisfactory overall results.

A superheater of the convection type is provided to produce 75 deg. F. superheat at full boiler output of 35,000 lb. of steam per hour. The steam remains dry down to the 125 lb. extraction opening in the turbine. A full complement of steam soot blower nozzles is provided for the boiler and the superheater.

Iowa, Illinois, and Indiana coals are the normal fuels available for this power station in Waterloo. These coals may be classified as low grade, high ash, high volatile, free-burning fuels, which will clinker if agitated. A chain grate stoker, therefore, is well adapted for the required service and the forced draft type was selected. The forced draft operation requires the maintenance of only a slight draft over the fire, about 0.15 in., and the control of air pressure by variation of fan speed permits maintenance of high efficiency over a wide range of load with only small loss

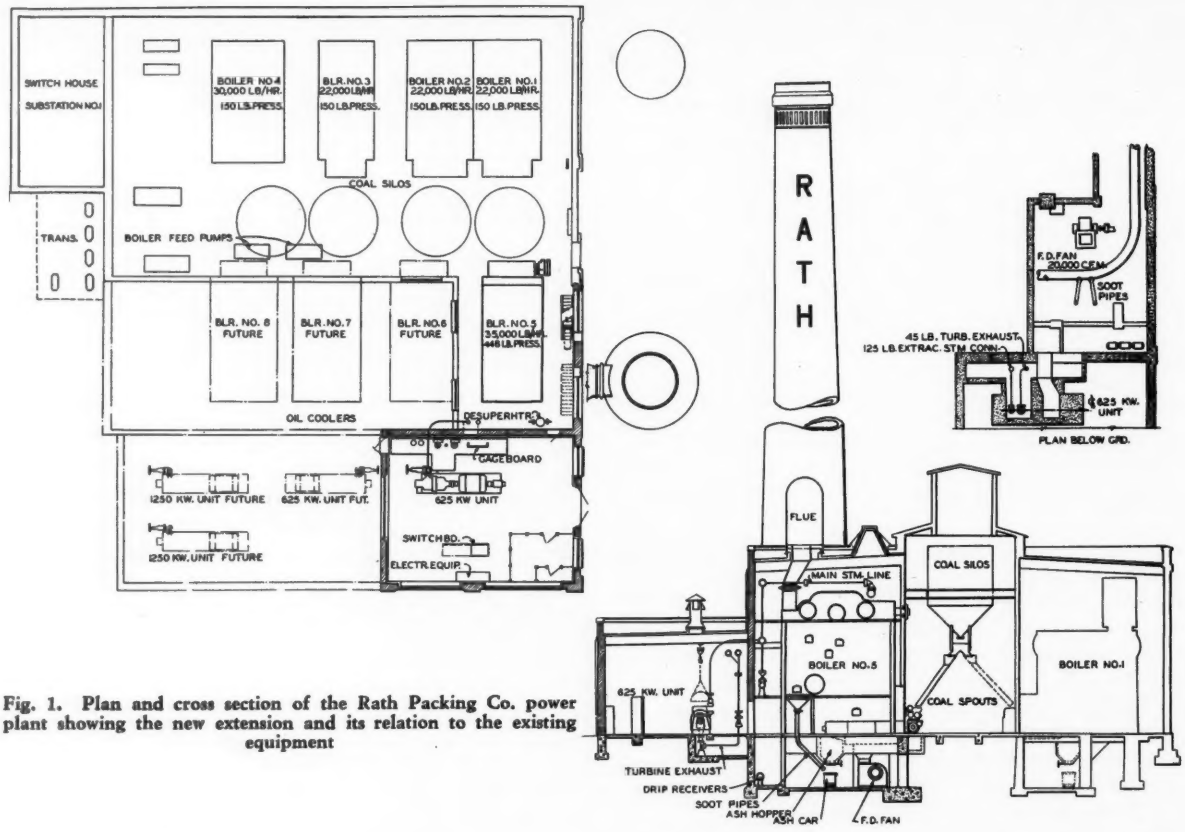


Fig. 1. Plan and cross section of the Rath Packing Co. power plant showing the new extension and its relation to the existing equipment

of carbon in the ash. The stoker is of liberal area and less than 40 lb. of coal per sq. ft. per hr. are burned at the maximum rate. There are nine tuyeres to control transverse air zones under the stoker. Air at less than 1 in. water pressure enters at each side of the plenum chamber. There is a double arch setting over the stoker, the rear arch being water-cooled and forming part of the boiler circulation. Bernitz Carbofrax air-cooled blocks are provided in the furnace walls at the level of the stoker to prevent abrasion by the moving fuel bed and to avoid clinker adhesion and slag erosion. The air which passes through these ventilated blocks reaches the furnace through nozzles located above the ignition arch. This secondary air, introduced as high velocity jets, protects the front arch and the agitation results in better combustion above the fuel bed by preventing stratification of the gases. Consequently, the conditions tend toward smokeless performance. The stoker is driven by a constant speed motor through a Reeves variable speed equipment adapted to automatic control.

The stoker installation, forced draft air duct connections, and the ash hopper construction are made so that it will be practicable to remove the stoker readily and then install natural gas and fuel oil burners if this becomes desirable.

Hagan automatic control governs the forced draft fan speed, rate of travel of the stoker, and the position of the boiler uptake damper, thereby maintaining proper balance in fuel-air ratio at all loads.

The boiler uptake passes through the building roof into the smoke flue which runs direct to the concrete stack erected on a foundation constructed at ground level and reaching to a height of 202 ft. This height matches that of the first stack which serves the 150 lb. boilers and is amply sufficient for furnace draft and to insure wide distribution of such fly ash matter as escapes from the furnace.

The boiler feed pumps were selected with characteristics so that they serve the 448 lb. boiler when operating at high speed, and as reserves to serve the 150 lb. boilers when operating at lower speeds. The flexibility of speed control of the turbine drives of these pumps permits this to be done readily. The 150 lb. boilers will continue in service for many years to come to supply 125 lb. steam above the capacity of the higher pressure boilers whose primary purpose will be to run the turbine generators.

A simple direct connected turbine generator was selected as the proper machine for the existing conditions. The generator is cooled by air entering through openings in the end casings. The air from the windings is discharged directly downward, which is a standard arrangement, and reaches the forced draft fan in the boiler room basement. This simple layout prevents excessive temperature in the turbine room in summer and warms the boiler room basement in winter. There is some slight thermal gain from the utilization of this warm air in the stoker wind box and the preheat aids somewhat in quick combustion of the coal. A by-pass connection with damper control is provided so that in winter any desired amount of generator air discharge can be recirculated to the turbine room for heating purposes. It is expected that the turbine gen-

Principal Equipment at the Power Plant (1934 Extension), The Rath Packing Company

GENERAL

Company—The Rath Packing Company.

Location—Waterloo, Iowa.

Service—Steam and Power.

Engineers and Supervisors of Construction—Stone & Webster Engineering Corp.

BOILER AND AUXILIARIES

Boiler—Combustion Eng. Co.—One bent tube type, four fusion welded drums and cross baffled for 3 passes. Boiler has 5360 sq. ft. of heating surface, including surface in rear arch of furnace, made up of 3¼ in. tubes.

Steam Drums—42 in. dia., bottom drum 48 in. dia. Boiler constructed for 448 lb. per sq. in. working steam pressure; capacity 35,000 lb. per hour, equivalent evaporation.

Superheater—The Superheater Co.—One Elesco convection type 1⅝ in. O. D. tubing designed for 75 deg. F. superheat at 35,000 lb. per hr. steam flow, located in front pass of boiler.

Soot Blowers—Diamond Power Specialty Corp.—Type G-2 independent valve.

Chain Grate Stoker—Illinois Stoker Co.—Type M forced draft; grate area 139.5 sq. ft.; length of grate 15 ft. 6 in.; width of grate 9 ft. 0 in.; nine tuyeres; drive 3 hp., 1160 r.p.m. motor through Reeves variable speed apparatus. Detrick front arch 8 ft. 6 in. long with air nozzles furnished with stoker. Stoker capable of operating boiler at a maximum rating of 225 per cent for 24 hr.

Forced Draft Blower—Clarage Fan Co.—One No. 2¼, type FD, DW-D1 direct connected to Terry turbine type Z1. Capacity of blower 20,000 c.f.m. at 3 in. water static pressure; speed 1550 r.p.m.

Combustion Control—Hagan Corp.—To control speed of forced draft blower, speed of stoker travel, and draft over fire.

Boiler Setting—National Power Construction Co., Chicago—18 in. solid brick settings using A. P. Green brick and bonding tile.

Ash Hopper Gates—Stephens-Adamson Mfg. Co.—Two rack and pinion type.

Smoke Flue—Spiegel Boiler and Welding Co., Waterloo, Iowa—$\frac{7}{16}$ in. steel plate reinforced with steel angles.

Chimney—Alphons Custodis Chimney Construction Co.—One 211 ft. by 10 ft. 6 in. dia. at top, reinforced concrete with 60 ft. hard burned brick lining at smoke flue opening; construction according to American Concrete Institute Standards.

FEED WATER SYSTEM

Boiler Feed Pumps—Pennsylvania Pump and Compressor Co.—Two 2½ in., four stage OMSB centrifugal, direct connected to Terry type Z4 single stage turbine; capacity each 160 g.p.m. of 212 deg. F. water against 490 lb. dynamic head, at 3000 r.p.m.

Feed Water Regulator—The Swartwout Co.—2½ in. "S-C" type.

Boiler Feed Pump Excess Pressure Regulator—Fisher Governor Co.

TURBINE GENERATOR AND AUXILIARIES

Turbine Generator—Moore Steam Turbine Corp.—One Moore non-condensing extraction type, 625 kw., 3600 r.p.m. turbine type S2B5, eight stage, extraction at 125 lb. per sq. in.; exhaust at 45 lb. per sq. in.; throttle pressure 430 lb. per sq. in.; superheat 75 deg. F. Turbine drives Westinghouse Electric generator, 2 pole, 3 phase, 60 cycle, 4150 v., 80 per cent power factor with direct connected shunt wound exciter for excitation at 125 v.

Switchboard—General Electric Company.

Switch Gear—General Electric Company.

Storage Battery—Electric Storage Battery Co.—24 v. tripping battery.

MISCELLANEOUS EQUIPMENT

Building Contractor—J. E. Currie Co., Waterloo, Iowa.

Electrical Contractor—Electrical Engineering & Construction Co., Des Moines, Iowa.

Piping Contractor—Geo. B. Limbert & Co., Chicago.

Pipe Covering Contractor—Prillman, Inc., Joliet, Ill.

Valves, boiler pop safety—Crosby Steam Gage & Valve Co.

Valves, boiler blow-off—Edward Valve & Mfg. Co.

Valves, stop-check—Edward Valve & Mfg. Co.

Valves, relief—Crosby Steam Gage & Valve Co.

Valves, gate—Chapman Valve & Mfg. Co.

Valves, extraction line non-return—Schutte & Koerting.

Valves, reducing—Fisher Governor Co.

Misc. Forged Steel Stop Valves—Edward Valve & Mfg. Co.

Non Return Valve—Edward Valve & Mfg. Co.

Boiler water column—Reliance Gauge Column Co. No. W-53.

Desuperheater—Elliott Company.

Steam trap—Nicholson & Co., W. H.

Liquid level controllers—McAlear Mfg. Co.

Furnace side wall blocks—Bernitz Furnace Appliance Co.

Drip receivers—Spreigel Iron Works.

Air compressor—Quincy Compressor Co.

Apexior treatment of boiler drums—The Dampney Co. of America.

INSTRUMENTS

Boiler meter—Bailey Meter Co.

Draft gages—Ellison Draft Gage Co.

Steam flow meters—Bailey Meter Co.

Recording thermometers and gages—Bailey Meter Co.

Indicating pressure gages—Marshalltown Mfg. Co.

Indicating thermometers—The Palmer Co.

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erator will operate practically continuously, the kilowatt-hour output varying with the amount of steam utilized at 45 lb. and 125 lb. pressure. About 40 per cent of the total electrical requirements of the packing plant will be generated by this unit as by-product electric power. The generator is wound for 4150 volts and the leads are connected direct to the present main substation bus.

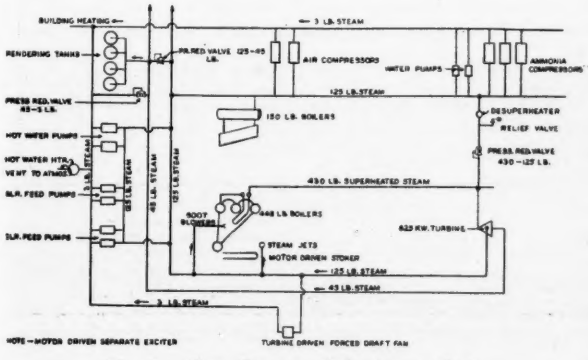


Fig. 2. Flow diagram of the power plant

The large motors driving the ammonia compressors take current at 4000 v., but otherwise the current is stepped down to 220 v. in five transformer substations strategically located throughout the packing plant. The lighting service, however, is 110 v.

This new extension to the power station results in practically complete flexibility to supply steam and electric power with proper heat balance at all times. As previously stated, the operator elects to utilize as much of the 45 lb. exhaust steam as he desires or simultaneously to use some 125 lb. extraction steam. He runs the 448 lb. boiler to supply only the steam requirements of the turbine or operates it continuously at full rating, passing the excess of steam not required by the turbine through the reducing valve and desuperheater into the 125 lb. steam header. Purchased power from the power company is connected in at all times and provision is made for synchronizing and for the control of power factor.

The foregoing description and drawings cover the practical solution of the steam and electric power problem for this particular packing plant. The accompanying tabulation shows the essential data for the equipment in the power station extension.

High Pressure Unit Justifies Investment

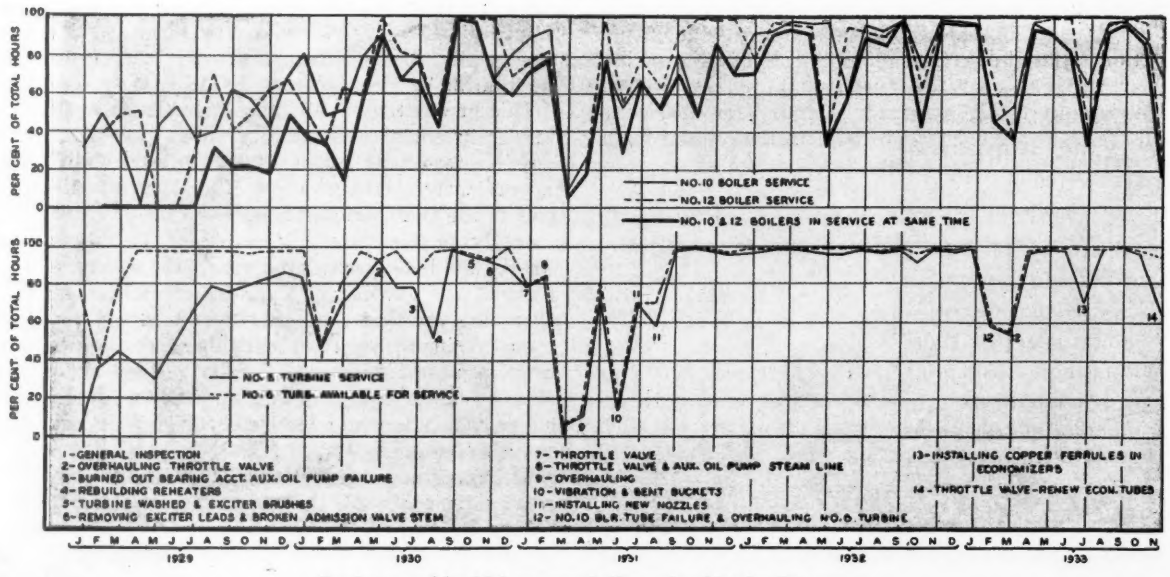
Experience at Northeast Station Shows Fuel Saving of $115,585 for One Year. By C. M. Duncan, Steam Division, Westinghouse Elec. & Mfg. Co., St. Louis, Mo.

AFTER FIVE YEARS OPERATION Kansas City Power & Light Co. report that the extra investment of its 1200 lb. pressure generating unit over 300-lb. equipment of the same capacity is fully justified. For example, during 1932, 13 per cent of the plant power was generated by the high pressure turbine, 50 per cent exhaust steam from the 1200 lb. unit and 37 per cent by other low pressure equipment. In addition to the plants increased capacity, the high pressure unit has made the efficiency of the combined plant comparable to that of newer installations. As compared with 300 lb. equipment, this combination saved 2440 B.t.u. per kw-hr., a saving in fuel alone of $115,585. In addition maintenance savings amounted to $24,297. The total saving is approximately 2½ times that required to justify the extra investment over that of a 300-lb. installation.

The installation consists of two 1700-hp., 1400 lb. pressure boilers and one 10,000-kw., 1200 lb. pressure turbine. The boilers are arranged for pulverized-coal firing, using the unit system pulverizer. Boilers are equipped with convection type superheaters, radiant reheaters and water walls. Each boiler is designed for a normal evaporation of 185,000 lb. per hr. and a maximum evaporation of 225,000 lb. per hr.

The turbine is a combination impulse-reaction type, with two rows of impulse blading and twelve rows of reaction blading. The reaction blading carries a shroud strip over the outer ends to form a close clearance with the adjacent row of blades. The clearance is made uniform throughout the turbine by rubbing the thin shroud strips against the projected strip of adjacent row of blading, while the turbine is on load and at normal operating temperatures. This clearance can then be varied between certain limits by means of an adjustable thrust bearing, which moves the turbine spindle axially.

The turbine was designed to operate with 1250 lb. throttle pressure, total steam temperature of .725 deg. F., and exhaust to the reheater at 315 lb. pressure.


PER CENT OF TOTAL HOURS
NO. 10 BOILER SERVICE
NO. 12 BOILER SERVICE
NO. 10 & 12 BOILERS IN SERVICE AT SAME TIME
NO. 5 TURBINE SERVICE
NO. 6 TURB. AVAILABLE FOR SERVICE
1 - GENERAL INSPECTION
2 - OVERHAULING THROTTLE VALVE
3 - BURNED OUT BEARING ACCT. AUX. OIL PUMP FAILURE
4 - REBUILDING REHEATERS
5 - TURBINE WASHED & EXCITER BRUSHES
6 - REMOVING EXCITER LEADS & BROKEN ADMISSION VALVE STEM
7 - THROTTLE VALVE
8 - THROTTLE VALVE & AUX. OIL PUMP STEAM LINE
9 - OVERHAULING
10 - VIBRATION & BENT BUCKETS
11 - INSTALLING NEW NOZZLES
12 - NO. 10 BLR. TUBE FAILURE & OVERHAULING NO. 6 TURBINE
13 - INSTALLING COPPER FERRULES IN ECONOMIZERS
14 - THROTTLE VALVE - RENEW ECON. TUBES
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N
1929
1930
1931
1932
1933

Service record for high pressure boiler and turbine for five years

From there the steam goes to the 300 lb. pressure header of old boilers. The high pressure turbine is installed in the boiler room, adjacent to the high pressure boilers. In addition to the above equipment in this plant, are eight 1350-hp., and four 1270-hp., 300-lb. boilers, two 30,000-kw., and three 23,000-kw., 300-lb. pressure turbines. The latter boilers and turbines have been in service 10 to 12 yr.

Excellent Availability Record

Availability and service of both the boilers and high pressure turbine is shown by the chart. The service and availability of the turbine has been high despite considerable outage during the first 3 mo., due to balance of generator rotor and minor adjustments and changes on turbine. The availability, after these corrections, was nearly 100 per cent until opened up for inspection after 13 mo. service. With the exception of a few minor items the turbine was in perfect condition.

During the second year the turbine continued to give almost equally good service. About March 1, 1931, it was taken out of service for the second annual inspection. At this inspection it was thought advisable to return the spindle to the factory and make some changes to the reaction blade shrouds and to the sealing rings, at the high pressure end of the spindle. New stationary packing strips were installed in the field. There seems to be no doubt that the trouble experienced, at this inspection, has been permanently corrected. Availability and service of turbine was nearly 100 per cent from July 1931 to February 1933, when again taken out of service for inspection. Only minor repairs were needed, at this inspection, and since then the turbine has been available almost 100 per cent.

At the time this installation was made, high pressure was more or less in the experimental stage. Now that the above mentioned troubles have been eliminated and settled down to normal operation, the availability and service is equally as good as on the lower pressures. Referring to the chart, it will be seen that the service and availability of the turbine has been somewhat better than the boilers so that at times, with only one boiler available for service, the turbine carried partial load.

The piping is arranged, so, that if it is desired to take the high pressure turbine out of service at any time, the steam from the high pressure boilers can be passed through a reducing valve and desuperheater to the reheater and 300 lb. header.

Scale Removed Without Injury to Blades

The formation of scale on the last three rows of reaction blading, was and still is, of considerable importance but no scale deposit has been found in the high pressure parts of the turbine. Scale appearing only on the last three rows of high pressure turbine blading and again in the lower stages of the low pressure turbines. The analysis of the scale, in the early period of operation, showed it to be quite insoluble in water. Some means had to be found to remove this scale without having to open the turbine each time. It was found first, that, when the turbine was shut down for a few days and allowed to cool, that most of the scale would break loose due to temperature changes or weathering. Later, a feed water treatment was found which produced a scale that was soluble in water and could be removed by washing with saturated steam.

This was done first by rolling the turbine at about 1000 R.p.m. and admitting water at the steam chest for a short period. This was effective in removing the scale, but it was felt that this method of washing might be responsible, due to rapid temperature changes, for wedges in the impulse blading coming loose, and it was quite evident that other means had to be found to remove the scale.

As the saturated steam seemed to be effective it was decided to desuperheat the steam in the following manner, so as to eliminate rapid temperature changes in the turbine. Two 9/32 in. orifices were installed in the sides of steam line near the boilers and approximately 60 ft. from the turbine. They were installed 3 ft. apart and entered the steam line at an angle of 45 degrees, up stream and connected to the high pressure feed water line with valves suitable for regulating the flow of water to steam line for desuperheating. These orifices furnish enough water to desuperheat 250,000 to 300,000 lb. per hr. of steam, depending on the differential pressure between the feed water and steam pressure.

When it is desired to wash turbine blading, the steam temperature is gradually decreased by admitting water through the orifices to the steam line. After the capacity of the water orifices is reached, the load on the turbine is decreased until saturated temperature is reached. The turbine is then operated for a short time with steam at saturated temperature. Then the temperature is allowed to raise gradually, first, by increasing the load on turbine, then by gradually shutting off the water supply. At least 2 hr. are taken to reduce the steam temperature and 2 hr. to bring it back to normal. This method has been in use about 3 yr. and seems to be the most effective way of removing scale from turbine blading, without injury to the turbine parts. This method should be equally effective on lower pressure turbines operating with high temperature steam.

Research work during the depression in the German steam boiler industry has been characterized as highly satisfactory by Dr. Friedrich Schulte, president of the Association for the Supervision of Power Equipment in the Ruhr coal mines. As reported through the Machinery Division of the Bureau of Foreign and Domestic Commerce, this progress has been particularly notable in the production of high pressure equipment using special steels of high tensile strength. Gas welding apparently predominates although electrical welding is gaining ground while riveting in the high pressure field has almost disappeared. The general tendency has been one of simplification which it is claimed has been carried so far that efficient high pressure boilers now cost but little more than low pressure boilers. Special attention has been given to the matter of water circulation, water cooled furnaces, draft control and the production of seamless boiler drums.

Combustion Control

Part V. Steam Pressure and Furnace Pressure or Draft Regulators

STEAM PRESSURE REGULATORS are built in many designs. Some of these are of the full stroke type and have but two damper positions, fully closed and fully open. Others are of the partial stroke type and will hold the damper in intermediate positions determined by the variation of steam pressure from normal. This is accomplished by means of a compensator which, as the piston moves, tends to return the pilot valve to a neutral position and prevent a full piston stroke for a small pressure change. Several regulators using a spring type compensator were described in the last issue.

A different method of compensation is shown by Fig. 1 on a regulator made by the Davis Regulator Co. When the steam pressure drops, the pilot valve is moved downward, around a movable fulcrum, and water is admitted to the bottom of the cylinder moving the piston upward. As the piston moves upward the compensator, with a sliding contact, raises the fulcrum and returns the pilot valve to its neutral position. The speed with which the pilot valve is returned to its neutral position can be adjusted by altering the slope of the compensator rod. The greater the slope the shorter the piston travel for each change in steam pressure. By this means the steam pressure variation, 5, 10 or 15 lb., necessary to cause a full stroke (a change from a fully closed to a fully opened damper position) can be adjusted as desired.

In the Atlas Valve Co. regulator shown by Fig. 2, compensation is by means of a shifting weight as described in detail in the caption. The arrangement of the pilot valve and cylinder is also different from those previously described in that the top of the cylinder is always subjected to full operating pressure. Downward movement of the operating piston, corresponding to a decrease in steam pressure, is accomplished by releasing the fluid pressure from the bottom of the cylinder through a leak port in the pilot valve after which the pressure on the top of the cylinder forces the piston downward. Upward movement of the piston, corresponding to an increase in pressure, is accomplished by admitting full fluid pressure to the bottom of the cylinder, when, because of the unbalanced piston area due to the piston rod, the piston is forced upward.

CORRECTION NOTE: PART IV.

When arranging the illustrations on pages 278 and 279 of the May 1935 issue, captions for Figs. 4 and 5 were transposed. The caption, Figure 4, for the Watts regulator refers to the small illustration at the top of the first column on page 279 and the caption, Fig. 5, for the Foster regulator refers to the large illustration at the bottom of page 278.

By adding weights to the end of the weighted lever the regulator may be adjusted to start closing the damper at any boiler pressure up to the allowable maximum for that model. By adding weights to the compensator the control piston may be adjusted to travel any desired distance for each point that the boiler pressure changes. That is, if the total travel is 10 in. and the compensator is adjusted to fully close the damper on a total increase of 5 lb., the travel will be 2 in. per lb. pressure change, if 10 lb., 1 in. and if 15 lb., 2/3 in.

Details of other types of regulators and compensators will be shown in succeeding articles of this series. The partial stroke regulators shown so far have compensators so designed that a given pressure change causes an equal piston travel in any position. That is, the piston with a 10 in. stroke, in a regulator adjusted to give full travel on a change in pressure of 10 lb., would travel 1 in. for each pound change in pressure whether at the top, bottom or middle of the cylinder. Furthermore, they have an infinite number of positions between the fully open and fully closed damper positions. Other regulators have compensators which limit the number of positions to say, 10 steps, which may or may not be equal. Still others have compensators which have an infinite number of positions but a given pressure change at the beginning of the stroke may cause a different piston travel than the same pressure change at the end, or middle, of the stroke. These types will be covered later.

Furnace Pressure or Draft Regulators

Fundamentally the problem of furnace pressure or draft regulator design is no different from that of steam pressure regulators except in the magnitude of the pressure to be controlled. Steam pressures may run up to several hundred pounds per square inch while drafts are measured in inches of water, in fact, often in hundredths of an inch, so that these regulators must be much more sensitive. The diaphragm type similar to the steam pressure regulator has been successfully applied to this service by making the diaphragm larger.

The inverted, liquid sealed bell, or as it is often called, the gasometer type, is also widely used. The bell may be double or single and a compensator may or may not be used in connection with the hydraulic operating cylinder when used for draft regulating service. Figure 3 shows a single bell type of the American Engineering Co. As can be seen from the illustration, the inverted cylinder acts directly on the weight arm of a hydraulic regulator in the same manner as, but with a longer lever arm than, in the case of the diaphragm regulator.

No matter whether air, steam, water or oil is used as the operating medium, the pull or power developed by the operating cylinder of any regulator depends upon three factors: the fluid pressure differential on the two sides of the piston; the net area of the piston; and the friction of the piston and compensating mechanism. The net area of the piston depends upon the diameter of the cylinder and the diameter of the piston rod. Thus neglecting friction, a 2½ in. piston with a 1 in. dia. piston rod would develop a pull, in pounds, of somewhat over five times the water

Fig. 1. Double acting hydraulic regulator with compensator, the Davis Regulator Co.

Steam pressure is piped to the top of diaphragm 1 and balanced, around the fulcrum 2A by suitable counterweights 3 on the lever arm 2. The pilot valve 4 admits operating pressure at either end of the cylinder 12 and exhausts from the opposite end to give a power stroke in either direction. A compensator or partial stroke toggle 6 pivoted around 6A limits the piston travel and prevents a full stroke of the piston on each slight change of steam pressure. One end of the compensator rod has a sliding contact 8 with the piston rod through 9 while the other end forms a floating fulcrum for the pilot valve lever 7A around pivot 7.

When the steam pressure drops, pilot valve 4 moves downward, admitting operating pressure to the cylinder through pipe 5 to move the piston upward. This action causes the floating fulcrum 7 to move the pilot valve upward to a neutral position and the action is stopped. A reverse cycle takes place when the control pressure increases.

Adjustment of the compensator to make it more or less effective is accomplished by setting the sliding contact 8 farther or nearer the piston rod 10. The farther it is moved to the left the more effective it becomes and therefore the shorter the movement of the piston rod for each increment change in the steam pressure. Changes in the setting of the compensator moves fulcrum 7 and affects the setting of the pilot valve making it necessary to move the other end of lever 7A (by means of the pilot valve adjustment) a sufficient distance in the opposite direction to bring the pilot valve back to neutral position.

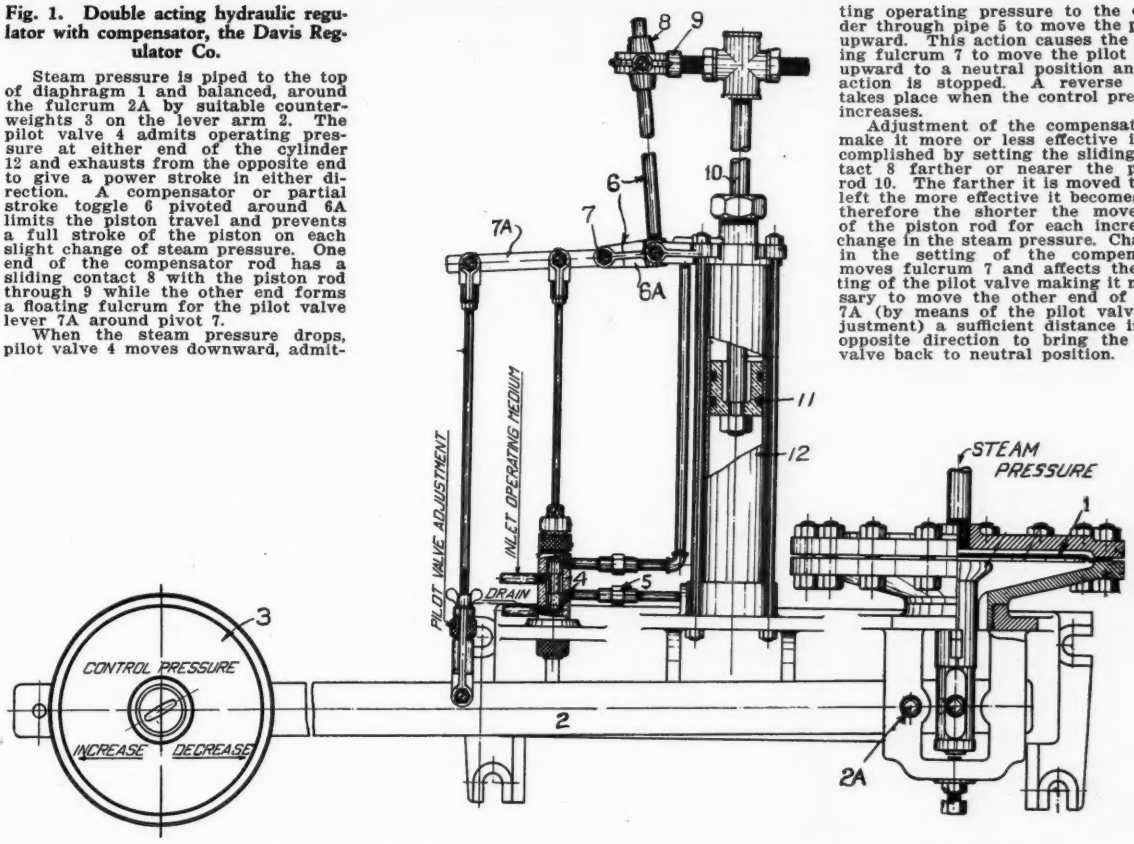
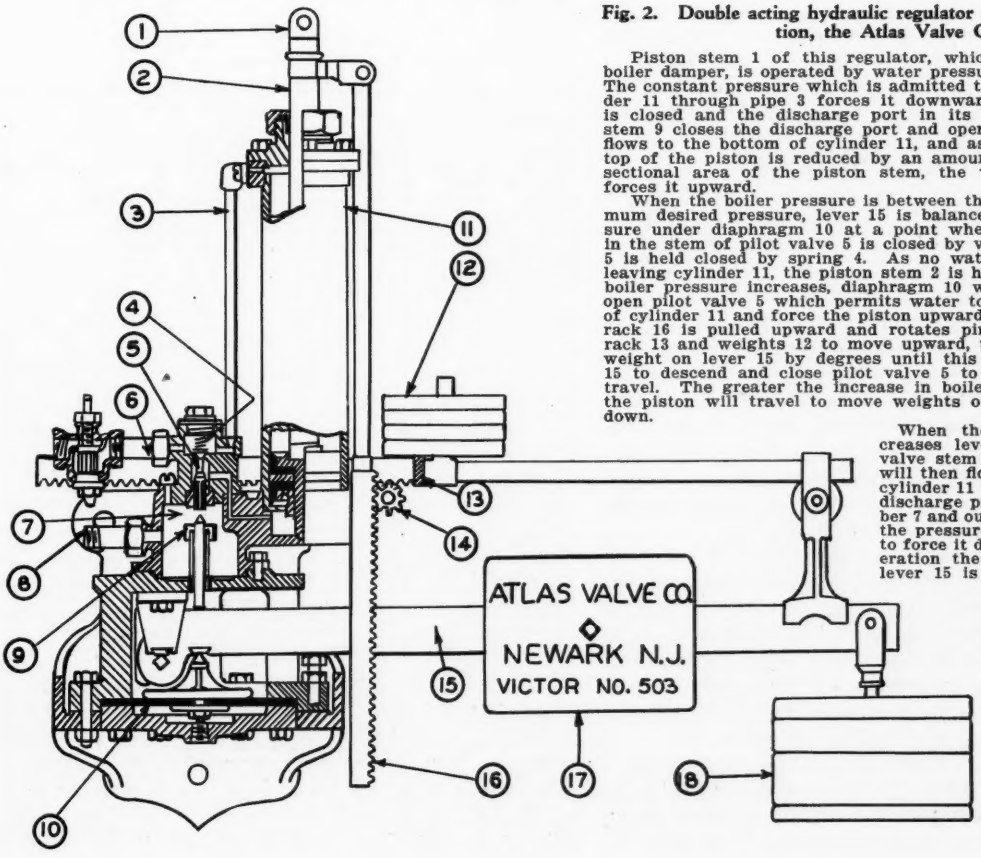


Fig. 2. Double acting hydraulic regulator with weight compensation, the Atlas Valve Co.

Piston stem 1 of this regulator, which is attached to the boiler damper, is operated by water pressure in either direction. The constant pressure which is admitted to the top of the cylinder 11 through pipe 3 forces it downward when pilot valve 5 is closed and the discharge port in its stem is open. When stem 9 closes the discharge port and opens pilot valve 5 water flows to the bottom of cylinder 11, and as the effective area on top of the piston is reduced by an amount equal to the cross-sectional area of the piston stem, the water pressure below forces it upward.

When the boiler pressure is between the minimum and maximum desired pressure, lever 15 is balanced by the steam pressure under diaphragm 10 at a point where the discharge port in the stem of pilot valve 5 is closed by valve stem 9 and valve 5 is held closed by spring 4. As no water is now entering or leaving cylinder 11, the piston stem 2 is held stationary. If the boiler pressure increases, diaphragm 10 will raise lever 15 and open pilot valve 5 which permits water to flow into the bottom of cylinder 11 and force the piston upward. As the piston rises, rack 13 is pulled upward and rotates pinion 14, which causes rack 13 and weights 12 to move upward, thereby increasing the weight on lever 15 by degrees until this increase causes lever 15 to descend and close pilot valve 5 to arrest further piston travel. The greater the increase in boiler pressure the higher the piston will travel to move weights out and bring lever 15 down.

When the boiler pressure decreases lever 15 will lower and valve stem 9 will fall, the water will then flow from the bottom of cylinder 11 through the pilot valve discharge port to discharge chamber 7 and out of drain 8 and permit the pressure on top of the piston to force it downward by which operation the weight bearing upon lever 15 is gradually diminished. This enables lever 15 to rise again, close the pilot valve discharge port and hold the piston stationary in the position into which it had been moved.



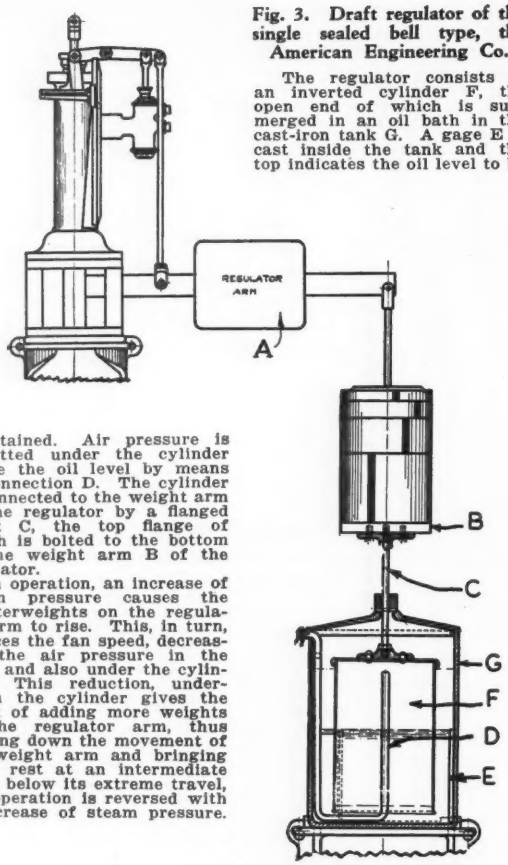


Fig. 3. Draft regulator of the single sealed bell type, the American Engineering Co.

The regulator consists of an inverted cylinder F, the open end of which is submerged in an oil bath in the cast-iron tank G. A gage E is cast inside the tank and the top indicates the oil level to be maintained. Air pressure is admitted under the cylinder above the oil level by means of connection D. The cylinder is connected to the weight arm of the regulator by a flanged shaft C, the top flange of which is bolted to the bottom of the weight arm B of the regulator.

In operation, an increase of steam pressure causes the counterweights on the regulator arm to rise. This, in turn, reduces the fan speed, decreasing the air pressure in the duct, and also under the cylinder. This reduction, underneath the cylinder gives the effect of adding more weights to the regulator arm, thus slowing down the movement of the weight arm and bringing it to rest at an intermediate point below its extreme travel, the operation is reversed with a decrease of steam pressure.

pressure in pounds per square inch, say 200 lb. for 40 lb. water, 250 lb. for 50 lb. water, etc. Friction might cut this down to, say, three and one-half or four times, or, 140 and 175 lb., respectively, for 40 and 50 lb. per sq. in. operating pressure.

The arrangement of the cylinder must be considered as well. In a cylinder arranged as in Fig. 1, the pull on the downstroke is less than the thrust on the upstroke due to the reduction in piston area by the piston rod. In this type of cylinder one end is connected to the drain while pressure is applied to the other end and with an open drain the effective pressure is practically the same as the operating pressure. In the cylinder shown by Fig. 2, the lower end is open to the drain and the full operating pressure is effective on the downstroke but on the upstroke full water pressure is applied to both sides of the piston and the upward thrust is equal to the effective pressure times the difference in areas on the two sides of the piston, that is, an area equal to that of the piston rod.

Operating fluid pressures range from 15 to 75 lb. per sq. in. depending upon the local source of supply. To take care of these differences in available pressures some manufacturers make several cylinder sizes ordinarily ranging from perhaps 2 to 4 in. in diameter. For damper regulation service a 10 in. stroke is common but this also varies from about 6 to 15 in. to meet the needs of different plants and equipment.

The diaphragm is also a matter of importance and in order to maintain the desired degree of sensitivity, the diameter is often varied with the pressure to be controlled. Thus one company uses a diaphragm 5¾ in. in diam. for pressures of 175 lb. per sq. in. and this is gradually increased in diameter for lower pressures, reaching 14 in. in the range from ½ to 20 lb.

An air operated draft controller, with a recorder as an integral part, built by the Bristol Co., is shown in Fig. 4. This controller consists of a sealed valve which measures the draft that exists in the furnace or stack and at the same time operates a control mechanism. This controller regulates the air pressure to an operating piston or diaphragm valve and this operating air pressure is varied by means of a free vane operated by the controller in such a way as to control the air leak through the orifice.

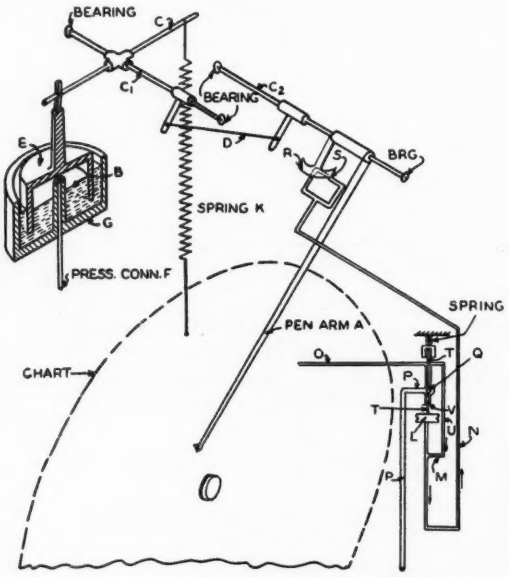


Fig. 4. Air-operated recording draft controller, The Bristol Co.

Draft pressure is conducted through pressure connection F to the inside of the cup which is sealed from the atmosphere by the oil whose level is shown at B. The cup is connected to one end of lever-arm C. As the pressure inside of the cup changes the cup rises and falls and by so doing, rotates shaft C_1 through a limited angle. The motion of shaft C_1 is transmitted to shaft C_2 through link D. To the shaft C_2 is connected penarm A and vane R. The penarm records the draft reading on a calibrated chart. The vane R operates the control mechanism as it rotates with the penarm. As it rotates it is free to pass between two nozzles shown at S, discharging jets of air in such a way that the vane in passing between the two jets of air throttles its discharge. It is by this throttling action that control is effected.

Air at 15 lb. per sq. in. is admitted at O and passes to the point where the upper end of shaft T is indicated. At this point the air flow is divided, part flowing downward to a 3-way pilot valve shown at Q and part flowing down through constriction M to the capsule spring L. The part flowing down through constriction is to retard the flow of air so that only a limited amount can pass through to the capsule spring or diaphragm L and the nozzles S. The nozzles are so proportioned in relation to the size of the constriction M that when their discharge is not throttled by the vane they permit enough air to escape so that there exists only a slight pressure in the diaphragm L.

As the edge of the vane R cuts into the jets of air the discharge from the nozzles is throttled, the amount of throttling depending upon the position of the vane across the nozzle opening. When the vane cuts entirely through the jets of air throttling is at a maximum value and pressure is built up in diaphragm L. This pressure distends the diaphragm and operated the 3-way pilot valve. Air flows through it whenever diaphragm L allows the pilot valve to open. During operation the ball of the 3-way pilot valve floats between the lower and upper valve seats varying the air pressure built up in the line P which furnishes air to the controlling mechanism.

This controlling mechanism may be a diaphragm valve or an air-operated piston and cylinder. As the pilot valve floats between the lower and upper valve seats a varying amount of air is permitted to leak out into the atmosphere through the opening V, when the ball of the pilot valve is not resting on the lower seat. When the pilot valve passes more air than can leak out to the atmosphere the pressure above the control apparatus (diaphragm valve or air-operated piston or cylinder) increases. Similarly when the pilot valve passes less air than can leak out into the atmosphere the pressure above the control apparatus decreases. Since the degree of opening of the diaphragm control valve or a damper depends upon the air pressure to which it is subjected, it follows that its position is dependent on draft.

The controller can be set at any draft value within the chart range. When the draft reaches the value of the control setting the control mechanism in the instrument begins to function to maintain that draft value within close limits.

Evaluating the Ignition Qualities *of* Diesel Fuels

Simple Relation Between Ignition Quality and Viscosity and Gravity. Determinations Pointed Out Before the A. P. I. By C. C. Moore, Jr., and C. R. Kaye, Union Oil Co. of California, Los Angeles, Cal.

UNTIL RECENTLY, the rotational speed of Diesel engines was slow in comparison with the actual delay of ignition; hence ignition lag did not markedly influence engine performance even in the case of fuels which had relatively poor ignition characteristics. Recent development of high-speed Diesel engines, however, has made ignition lag a factor of paramount importance in Diesel engine operation. It has been commonly believed that the physical properties and ignition characteristics are more or less unrelated and the primary purpose of this article is to show that two of the most commonly determined physical properties of Diesel fuel, viz.. gravity and viscosity, affords a definite, reliable, and accurate indication of ignition quality.

For the purpose of this article, ignition may be defined as the spontaneous generation of a flame of sufficient magnitude to insure the complete combustion of the atomized fuel in the combustion chamber. Given the necessary requirements of temperature, pressure, fuel atomization and time, the ease with which a fuel ignites in a Diesel engine is mainly dependent upon its chemical nature. Fuel ignition never occurs simultaneously with the first appearance of the fuel in the combustion chamber, but at some time interval thereafter. This interval is termed the ignition delay or ignition lag, and its duration is a measure of the ignition quality of the fuel oil.

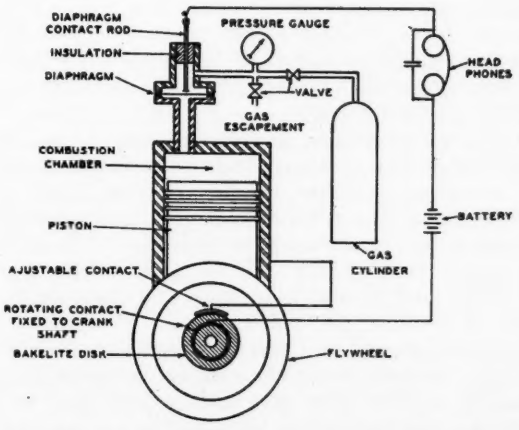


Fig. 1. Schematic diagram of apparatus used to determine combustion chamber pressures

As a result of ignition delay, unburned fuel accumulates in the combustion chamber of the engine during the early stages of each firing cycle. A long ignition delay will cause an excessive amount of unburned fuel to accumulate; and when this accumulation is finally ignited, the pressure rise will be considerably in excess of safe or desirable limits and this pressure rise will occur very rapidly producing what is known as a Diesel knock. This may be even more detrimental to good operation in a Diesel engine than detonation in a gasoline engine.

Fuels which have poor ignition quality are, therefore, the most common cause for knocking or rough-running Diesel engines. Ignition quality also markedly affects the ease with which a cold engine can be started. Fuel requirements for good combustion may differ somewhat from the requirements that are prerequisite for good ignition. Once effective ignition has been obtained, however, the actual combustion of typical Diesel engine fuels proceeds to completion if the engine is properly adjusted. In fact, it may be said that nearly all difficulties that apparently result from improper fuel combustion, such as knocking, rough running, loss of power, a smoky exhaust and difficulty in cold starting, are primarily caused by poor fuel ignition.

Delay Number

For a Diesel engine running at constant speed, ignition may be conveniently expressed by the term "delay number," i.e., the number of degrees that the crankshaft rotates in the interval between the beginning of fuel injection and the moment of fuel ignition. A determination of delay number requires the measurement of the exact instant at which the ignition of the injected fuel occurs. The apparatus that was used for making these measurements consists essentially of a so-called balanced diaphragm unit, a rotating electrical contact or selector, a telephone head set, and a storage battery, arranged as shown by Fig. 1. The engine used was the single-cylinder variable-compression C.F.R. engine with a good deal of modification to improve its performance. Better operation resulted when the inlet air was supercharged to a pressure of about 10.5 lb. per sq. in. gage, and heated to 260 deg. F.

Test data were obtained with the engine operating under the following standard test conditions: Engine speed, 600 r.p.m.; oil temperature, 130-140 deg. F.; jacket-water temperature, 212 deg. F.; fuel tempera-

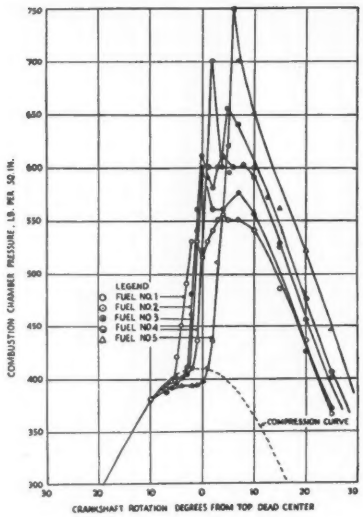


Fig. 2. Indicator cards for 5 fuels injected 10 deg. before top dead center on the test engine

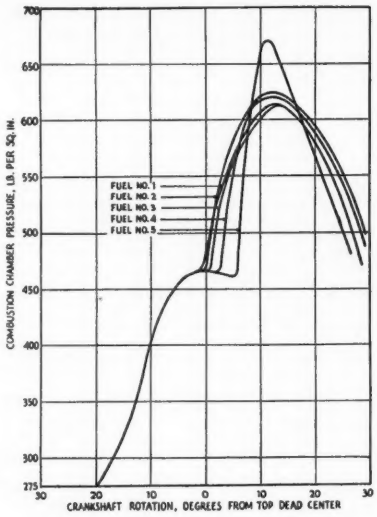

COMBUSTION CHAMBER PRESSURE, LB. PER SQ. IN.
CRANKSHAFT ROTATION, DEGREES FROM TOP DEAD CENTER
FUEL NO. 1
FUEL NO. 2
FUEL NO. 3
FUEL NO. 4
FUEL NO. 5

Fig. 3. Indicator diagram for 5 fuels injected 4 deg. before top dead center on a commercial 75-hp. Diesel

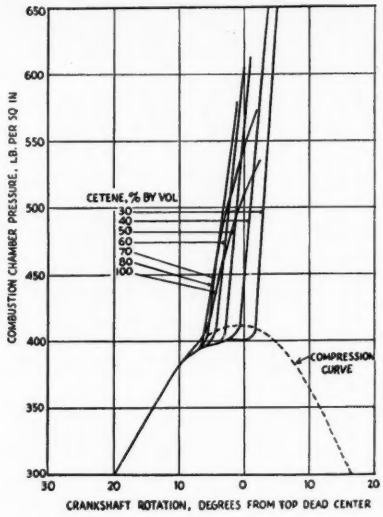


Fig. 4. Indicator cards for blended fuel injected 10 deg. before top dead center of the test engine

ture, 80-100 deg. F.; fuel line pressure, 2000-3000 lb. per sq. in.; maximum compression pressure (supercharged) 400 lb. per sq. in. gage; beginning of fuel injection, 10 deg. before top dead center; fuel feed, adjusted to give a slightly hazy exhaust.

Since it is possible to determine, within 4 or 5 lb. the pressure of the gases in the combustion chamber at any point in the engine cycle by means of the apparatus described, complete pressure-time diagrams may be constructed for a given fuel which relate the combustion-chamber pressures to angularity from the zero or top-dead center position of the crankshaft. For our purposes, however, it is unnecessary to construct such a diagram over the entire engine cycle, as it is sufficient to obtain only that portion which includes fuel injection, fuel ignition, maximum firing pressure and a sufficient section of the curve following the peak pressure to establish the contour.

The delay number (number of degrees of crankshaft rotation between beginning of fuel injection and fuel ignition) of the fuel under test can readily be determined, since the pressure-time diagram will indicate clearly the position of the sudden pressure rise in the combustion chamber due to the ignition of the fuel. Typical pressure-time diagrams obtained in this manner on the modified C.F.R. Diesel engine are shown in Fig. 2. These five curves represent material having a considerable range in ignition quality, and the delay numbers will be observed to vary from 4.5 deg. for fuel No. 1 to 10.0 deg. for fuel No. 5. After ignition occurs, the extent of the pressure increase in the combustion chamber is seen to be proportional to the ignition delay, as those fuels which have a long ignition delay produce exceedingly high maximum firing pressures.

Figure 3 shows the pressure-time diagrams of these same five fuels on a 75-hp. 3-cylinder commercial Diesel engine which was operating under constant conditions at 450 r.p.m. and about three-quarters load. The apparatus necessary to make these determinations was installed on the engine, and the data were then obtained by the same procedure that was used on the experimental Diesel engine in our laboratory.

A comparison of Fig. 2 with Fig. 3 indicates an identical order of rating was obtained with these five fuels on both engines, although it will be observed that their delay numbers in the commercial engine differ by a reasonably constant amount from their C.F.R.-engine delay numbers. It will also be observed that the peak pressure curves in the commercial engine are smooth and rounded, whereas they are sharply peaked and jagged in the modified C.F.R. Diesel engine. These differences can probably be accounted for by the superior design of the combustion chamber of the commercial engine, and by its somewhat slower speed and larger bore.

It is quite obvious from the foregoing that if the ignition quality of Diesel fuels is expressed in terms of delay number, the results are comparable only when obtained by a definitely standardized engine and under definitely standardized conditions. In order to eliminate substantially the so-called engine factor, Boerlage and Broeze have suggested that, as in the case of gasoline, the ignition quality of a Diesel fuel may be expressed in terms of equivalence to a blend of two standard materials—one having good ignition quality, and the other poor ignition quality. Two materials which have properties that are suitable for this purpose are cetene and alpha methylnaphthalene. Cetene is a sixteen-carbon-atom straight-chain compound having one unsaturated bond and exceptionally good ignition qualities. Alpha methylnaphthalene, on the other hand, ordinarily will not ignite in a Diesel engine.

Pressure time diagrams obtained with these blends are shown in Fig. 4. The relationship between cetene number, i.e., the per cent by volume of cetene in a blend of cetene and alpha methylnaphthalene and delay number are shown in Fig. 5. Figure 5 is, of course, only valid for test data obtained on this particular modified C.F.R. Diesel engine and by our particular test method. Since all the Diesel fuels discussed in

this article were rated in the same manner, however, Fig. 5 furnishes a convenient means of converting their delay number into cetene number. A Diesel fuel having a delay number between 6.0 deg. and 6.5 deg. is seen to have a cetene number of about 55. This is a typical value for a distilled California Diesel-engine fuel oil from Los Angeles Basin crude.

Chemical characteristics of Diesel fuels having good ignition quality are the reverse of those characteristics that produce a high-octane-value gasoline. Materials containing a large proportion of paraffinic components tend to produce Diesel fuels having excellent ignition

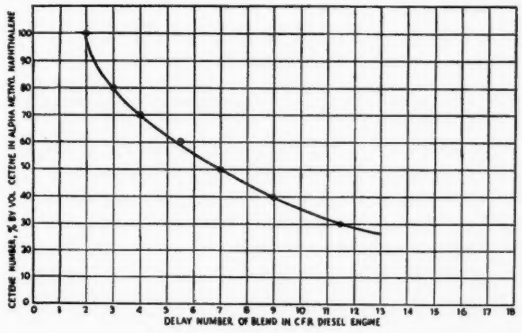


Fig. 5. Correlation of the delay number on the test engine plotted against the cetene number of the fuel

qualities and gasolines having poor octane values. Conversely, large proportions of aromatics or cyclic compounds degrade the ignition qualities of Diesel fuels while they improve the knock-rating characteristic of gasoline.

It might be expected, therefore, that a crude oil that produces gasoline having a relatively poor knock rating would produce a Diesel fuel with good ignition quality, and vice versa. We have accumulated a considerable amount of experimental data which confirm this relationship. We have also observed that a partially-cracked material, such as cycle stock, will invariably show poorer ignition characteristics. This is precisely in accordance with expectations, inasmuch as cracking reduces the paraffinicity of a material and increases the proportion of aromatics and unsaturated components.

V-GC vs. Ignition Quality

When it was observed that the paraffinicity of a Diesel fuel was so clearly reflected by its ignition quality, it seemed possible to base a fairly close estimate of the ignition quality on a knowledge of the viscosity-gravity characteristics of a Diesel fuel. Since the viscosity-gravity constant could be readily determined from the viscosity and gravity determinations that are regularly made on Diesel fuels, it was considered desirable to ascertain the relationship between ignition delay and this constant which may be calculated from the equation:

$$G = 1.082A - 0.0887 + (0.776 - 0.72A)(\log \log (KV-4)$$

where: G = specific gravity at 60 deg. F.; A = viscosity-gravity constant; KV = kinematic viscosity in millistokes at 100 deg. F. Experimentally determined delay numbers of a wide variety of Diesel-engine fuel oils of many representative foreign and domestic oil companies, when plotted against their respective viscosity-gravity constants, calculated by the formula just given, fall on a smooth but slightly curved line. Such a plot establishes a significant correlation between the delay number on the modified C.F.R. Diesel engine and the viscosity-gravity constant of Diesel fuels over an exceedingly wide range. It is seen that the ignition quality of a Diesel fuel is a function of its paraffinicity, for which the viscosity-gravity constant is a satisfactory expression. The proof of this relationship is of a great value, inasmuch as it reduces the necessity for engine rating as a means for determining the ignition quality of a Diesel fuel.

Combining such a curve with Fig. 5 shows that the cetene number is a straight line function of the viscosity-gravity constant. This justifies the conclusion that ignition delay is a function of the paraffinicity of the fuel, and independent of viscosity over the usual range.

Inasmuch as the determination of the viscosity-gravity constant of a Diesel fuel either involves a laborious calculation from an empirical formula, or the use of a special nomographic chart, the accompanying table was constructed to eliminate the necessity of the actual determination of this value. This shows the cetene numbers of Diesel-engine fuels, directly in terms of their A.P.I. gravity at 60 deg. F. and their Saybolt Universal viscosity at 100 deg. F.

Tabulation of cetene numbers corresponding to viscosities and gravities of Diesel engine fuel oils

Viscosity (Saybolt Universal Seconds at 100 Deg. F.)	Gravity (Deg. A.P.I. at 60 Deg. F.)																
	18	20	22	24	26	27	28	29	30	31	32	33	34	35	36	37	38
34	21	25	29	33	37	39	40	42	44	46	47	49	51	52	54	55	57
35	22	26	30	34	38	40	42	44	46	48	49	51	53	54	56	57	59
36	23	27	31	35	39	41	43	45	47	49	51	52	54	56	58	59	61
37	24	28	32	36	40	42	44	46	48	50	52	53	55	57	59	60	62
38	24	29	33	37	41	43	45	47	49	51	53	54	56	58	60	61	63
39	25	29	33	37	41	43	45	47	49	51	53	55	57	59	61	62	64
40	25	30	34	38	42	44	46	48	50	52	54	56	58	60	62	63	65
42	26	30	35	39	43	45	47	49	51	53	55	57	59	61	63	64	66
44	26	31	35	40	44	46	48	50	52	54	56	58	60	62	64	65	67
46	27	32	36	41	45	47	49	51	53	55	57	59	61	63	65	66	68
48	27	32	36	41	45	47	49	51	53	55	57	59	61	63	65	67	68
50	28	33	37	42	46	48	50	52	54	56	58	60	62	64	66	68	69
60	29	34	39	43	47	50	52	54	56	58	60	62	64	66	68	69	70
80	31	35	40	45	50	52	54	56	58	60	63	65	67	69	71	72	..
100	32	37	42	47	52	54	56	58	60	62	65	67	69	71	..	..	..
150	34	39	44	49	54	56	58	60	63	65	67	69	72	.	.	..	..
200	35	40	45	50	55	58	60	62	65	67	69	71	.	.	.	..	..
300	36	41	47	52	57	60	62	65	67	69	72	.	.	.	.	..	..
400	37	42	48	53	59	61	64	66	68	71	.	.	.	.	.	..	..
500	38	43	49	55	60	63	65	67	70	.	.	.	.	.	.	.	..

We have found that this table values which correspond with the most carefully performed engine ratings. The data in the table may be limited in their application to typical petroleum hydrocarbons and are not necessarily valid for synthetically prepared or "doped" fuels.

Conclusions

To summarize briefly the work presented here, the ignition delay of various Diesel fuels has been correlated with the cetene number (per cent of cetene in a blend of cetene and alpha methylnaphthalene), and also with the viscosity-gravity constant. From these correlations it has been possible to relate cetene number and viscosity-gravity constant, with the result that a very accurate estimation of the ignition characteristics of a Diesel fuel may be obtained simply from the routine determination of its viscosity and gravity and the use of the table.

Economy in the Generation *and* Use *of* INDUSTRIAL POWER *and* STEAM

By Linn Helander

Professor of Mechanical Engineering

Kansas State College

Manhattan, Kans.

Part II—Use of heat balance diagrams to indicate the possibilities of improving economy in an industrial plant is recognized as the most satisfactory method available. This method of predicting performance of proposed plant equipment presupposes data on the efficiencies of the various units of equiment to be installed, manufacturers' guarantees usually being satisfactory. Using principles explained in Part I this concluding article presents solutions to case problems that are typical of industrial plants.

IN ORDER to illustrate the principles set forth in Part I of this series published in the May issue, two cases will now be considered. One of these, illustrated in Fig. 1, deals with an industrial plant which generates in the form of by-product power, all of the power that it requires, so that condensers in the power plant are not required. The other, illustrated in Fig. 2, deals with an industrial plant that receives some of its power from condensing units. The two cases have been chosen with a view toward obtaining comparable effects when operating conditions are changed, so far as this is possible, so that the reader may gage the relative importance of the various means employed for effecting improvements in economy.

For each of the cases, several schemes for improving the fuel economy, some of which are effective, and some of which are not effective, are examined. For Case I, these schemes are illustrated in Figs. 1B to 1H; for Case II, in Figs. 2B to 2D. In each case, the result of a change in operating conditions is indicated in the caption of the figure illustrating the change. A study of the various figures and their captions will verify the following:

(1) When all power required can be generated in the form of by-product power without bleeding steam from the turbine for heating feedwater, then bleeding steam from the turbine for heating feedwater has no effect on the heat economy of the plant. See Fig. 1B.

(2) When all of the power required can be generated in the form of by-product power without bleeding steam for some particular process which consumes steam, then bleeding steam from the turbine for that process has practically no effect on the economy of the plant. See Fig. 1C.

(3) When all of the power required can be generated in the form of by-product power with steam supplied to the turbine at a given pressure, then increasing the pressure of the steam supplied to the turbine, or its temperature, will have practically no effect on the economy of the plant. See Fig. 1D.

(4) When all of the power required is generated in the form of by-product power and the installation of multiple effect evaporators does not alter this, then the substitution of multiple effect evaporators for single effect evaporators substantially reduces the heat consumption of the plant, even though the exhaust pressure on the turbines may be increased when the multiple effect evaporators are installed. See Fig. 1E.

(5) When all of the power required is generated in the form of by-product power, bleeding steam from between the effects of multiple effect evaporators for use in other processes is an effective way of reducing the heat consumption of an industrial plant. See Fig. 1F.

(6) When all of the power required is generated in the form of by-product power, recovering hot condensate and heat from such condensate is an effective way of reducing the heat consumption of an industrial plant. See Fig. 1G.

(7) When all of the power required is generated in the form of by-product power, a heat pump or vapor compressor may be used effectively to reduce the heat consumption of an industrial plant, this pump being used to recover heat from a low temperature source or steam from a low pressure region for use in processes or to heat feedwater. See Fig. 1H.

(8) When some part of the power required is generated by condensing units, bleeding steam from the turbine to heat feedwater is an effective way of reducing the heat consumption of the plant. The recovery of hot condensate in this case is advisable, but the

heat saved when regenerative feedwater heating is employed will only be a fraction of the heat in the condensate recovered. See Fig. 2B.

(9) When some part of the power required is generated on condensing units, increasing the pressure and the temperature of the steam at the turbine throttle reduces the heat consumption of the plant effectively. See Fig. 2C.

(10) When some part of the power required is generated on condensing units, installing multiple effect evaporators to replace single effect evaporators may have little effect on the heat consumption of the plant if the pressure of bled or exhaust steam must be increased to make that replacement possible. See Fig. 2D.

Figure 3 shows a plot of heat consumption versus power load for an industrial plant wherein the process heat demand is constant as the power load is varied. Curves are given for pressures of 450, 650 and 1250 lb. per sq. in. at the turbine throttle. The steeper lines

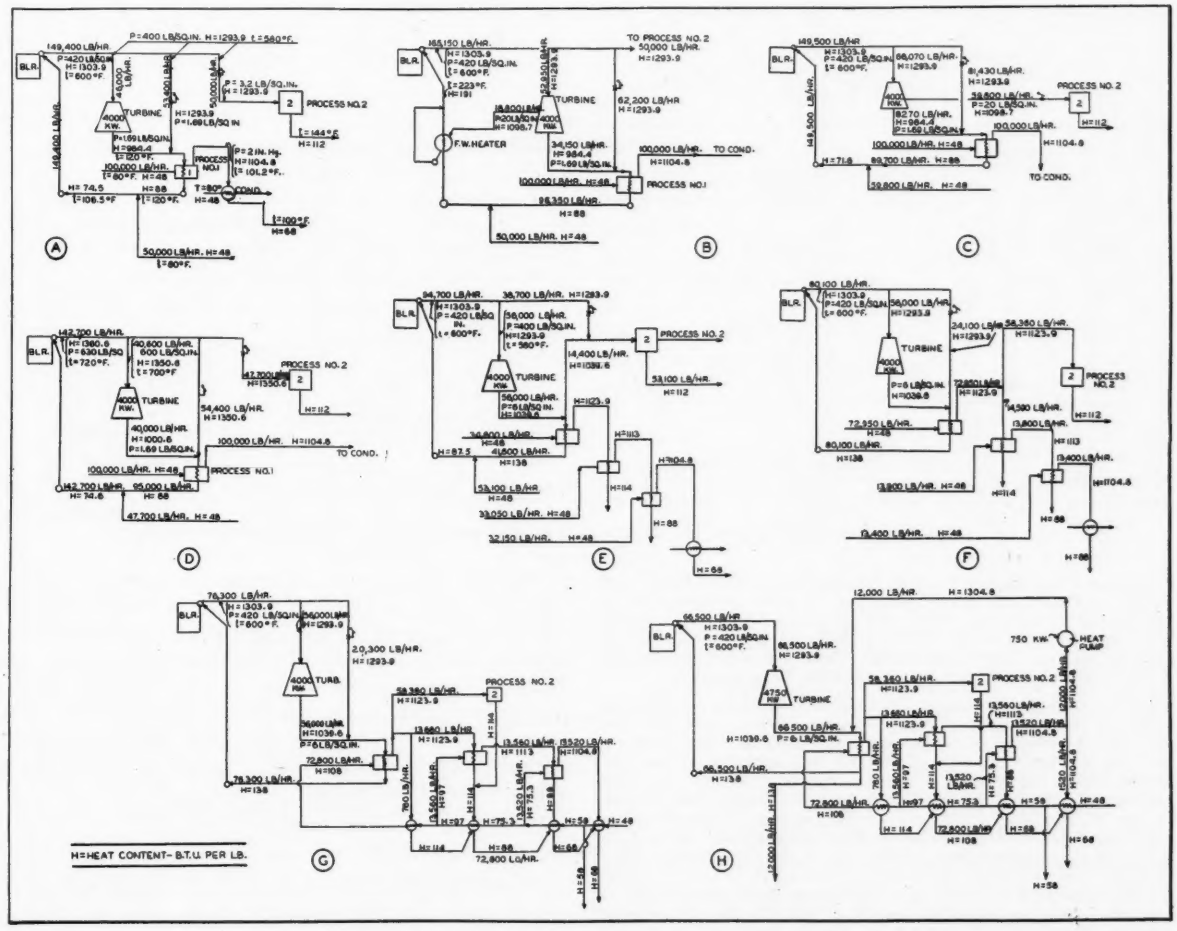


Fig. 1. Heat balance diagrams for noncondensing, by-product power plant

Fig. 1A. Original heat balance diagram of industrial plant considered in Case I, in which all power used is generated in the form of by-product power, no condenser being used in the power plant itself. Excluding the boiler room, reductions in heat consumption can be effected in this case only by reducing the heat consumption of the industrial processes. Heat consumption = 149,400 (1303.9 — 74.5) = 183,672,000 B.t.u. per hr.

Fig. 1B. Bleeding turbine to heat feedwater under Case I. The heat consumption is unaffected. Heat consumption = 165,150 (1303.9 — 191) = 183,672,000 B.t.u. per hr.

Fig. 1C. Bleeding steam for process No. 2 from turbine at pressure of 20 lb. per sq. in. abs. under Case I. Except for the slight increase in heat loss with condensate from process No. 2, amounting to approximately 600,000 B.t.u. per hr., there is no change in heat consumption. Heat consumption = 149,500 (1303.9 — 71.6) = 184,250,000 B.t.u. per hr.

Fig. 1D. Pressure at turbine throttle increased from 400 lb. per sq. in. to 600 lb. per sq. in. under Case I; temperature increased from 580 deg. F. to 700 deg. F. There is no change in heat consumption except for a negligible reduction in loss of heat with condensate from process No. 2. Heat consumption = 142,700 (1360.6 — 74.6) = 183,500,000 B.t.u. per hr.

Fig. 1E. Substitutions of three-effect evaporators for single-effect evaporators under Case I. Heat consumption is reduced approximately 68,500,000 B.t.u. per hr. Heat consumption = 94,700 (1303.9 — 87.5) = 115,200,000 B.t.u. per hr.

Fig. 1F. Bleeding steam from cross-over pipe between first and second effects of evaporator in Case I for process No. 2. Heat consumption is reduced approximately 21,700,000 B.t.u. per hr. Heat consumption = 80,100 (1303.9 — 138) = 93,500,000 B.t.u. per hr.

Fig. 1G. Same as Fig. 1E except that heat in condensate from process No. 2 and evaporator effects is recovered, and in addition a certain amount of heat is recovered from the evaporator condenser. Reduction in heat consumption due to recovery of this heat is 4,500,000 B.t.u. per hr. Heat consumed equals 76,300 (1303.9 — 138) = 89,000,000 B.t.u. per hr.

Fig. 1H. Installation of a heat pump (in this case a vapor compressor) to recover waste heat from last evaporator effect for re-use in first effect. Reduction in heat consumption is 11,500,000 B.t.u. per hr. under conditions shown and somewhat greater if heat in condensate wasted at first effect is recovered. Heat consumed = 66,500 (1303.9 — 138) = 77,500,000 B.t.u. per hr. Assumed over-all efficiency of vapor compressor, 66 per cent

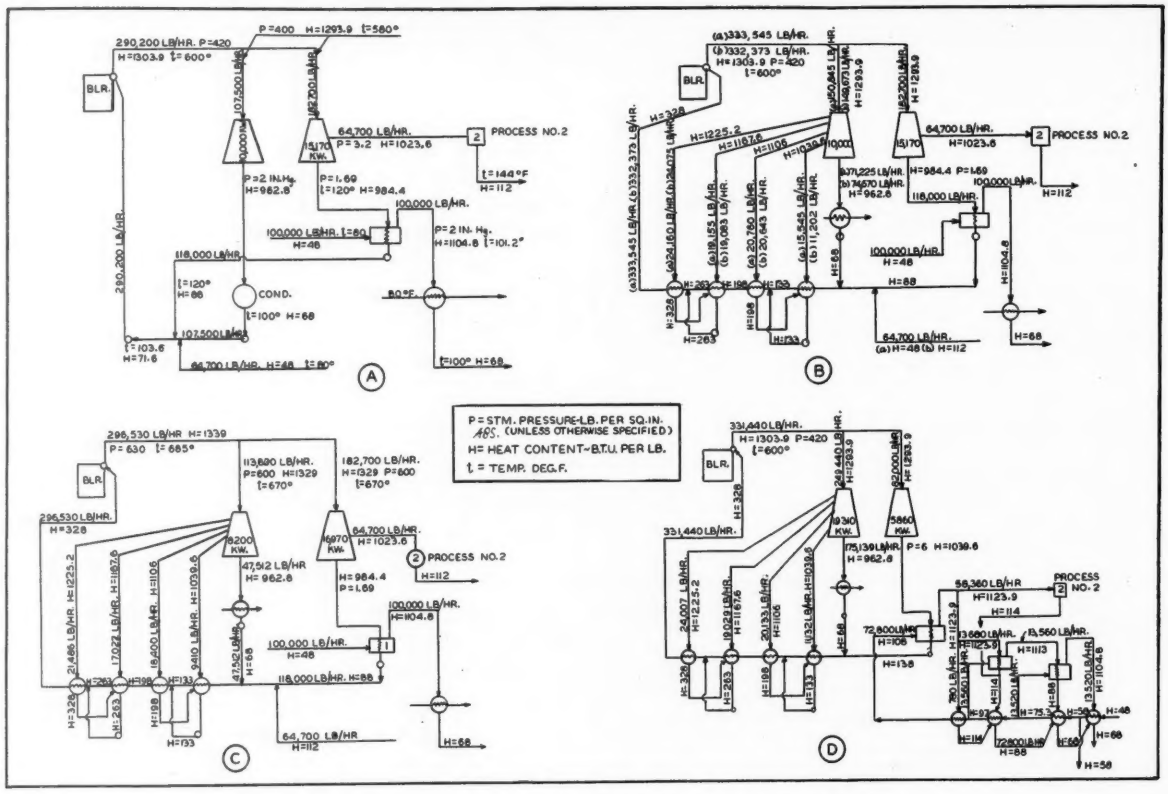


Fig. 2. Heat balance diagrams for industrial heat and power plant employing condensers

Fig. 2A. Original heat balance diagram of industrial plant considered in Case II, in which some part of power generated is developed by condensing units. For this case, any of the means for improving economy usually employed in central station practice will be found applicable. Heat consumed = 290,200 (1303.9 — 71.6) = 357,600,000 B.t.u. per hr.

Fig. 2B. Bleeding turbine at four points to preheat feedwater in Case II. Items marked "a" in diagram apply when the condensate from process No. 2 is wasted, the make-up water temperature being 80 deg. F. Items marked "b" apply when the condensate from process No. 2 is recovered as feedwater at a temperature of 144 deg. F. Reduction in heat consumption effected by use of four-stage feedwater heating equals 32,000,000 B.t.u. per hr. Additional reduction in heat consumption effected by recovering condensate from process No. 2 equals 1,100,000 B.t.u. per hr. Heat consumed in Case a = 333,545 (1303.9 — 328) = 325,506,000 B.t.u. per hr. (condensate from process No. 2 wasted). Heat consumed in Case b = 332,373 (1303.9 — 328) = 324,365,000 B.t.u. per hr. (condensate from process No. 2 recovered). It will be noted that although 4,130,000 B.t.u. are recovered in Case b with the recovery of condensate from process No. 2, the effect of this is to reduce the total heat consumption only 1,100,000 B.t.u. per hr.

Fig. 2C. Pressure at turbine throttle increased from 400 lb. per sq. in. to 600 lb. per sq. in.; temperature increased from 580 deg. F. to 670 deg. F. Reduction in heat consumed = 24,570,000 B.t.u. per hr. Heat consumed = 299,792,000 B.t.u per hr.

Fig. 2D. Substitution of three-effect evaporators in Case II for single effect evaporators, bleeding for process No. 2 from crossover pipe between first and second effects. Under the particular conditions here assumed there is an indicated reduction in heat consumption of approximately 900,000 B.t.u. per hr. compared with Case b, Fig. 2A; but this is obviously a negligible reduction considering that the same substitution in Case I, wherein power was generated exclusively in the form of by-product power, resulted in a reduction in heat consumption of slightly over 90,000,000 B.t.u. per hr. Heat consumed 323,452,000 B.t.u. per hr.

on this figure represent condensing power generation with steam bled for processes, the other lines the generation of power exclusively in the form of by-product power. It will be obvious from an inspection of this figure that the most favorable case for high pressure steam is that in which some part of the power required is continuously developed on condensing units; the most unfavorable case is that in which no part of the power required is generated on condensing units. Curves of this nature will be found helpful in determining what steam conditions should be employed in a given industrial plant.

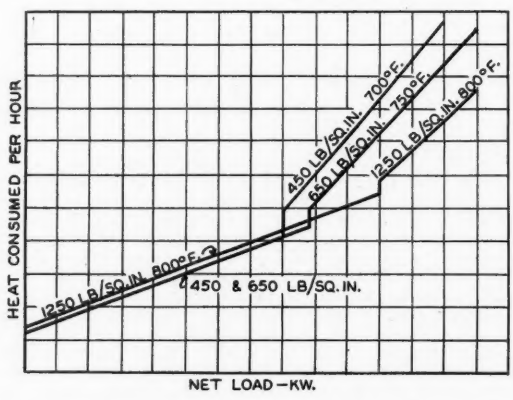


Fig. 3. Heat consumption curves for industrial power plant supplying power and process steam

Lines with the steeper slopes represent partly condensing operation; the other lines non-condensing operation wherein all exhaust heat is utilized by the industrial processes. It will be obvious from this figure that the conditions most advantageous for the adoption of high steam pressures are those under which some part of the power generated is developed on condensing units

Pumped Storage *in the Pyrenees*

TO EVEN UP power requirements with stream flow, a pumping plant with capacity of 20,000 g.p.m. against 1555 ft. head has been installed at the Lassoula reservoir, midway between Lakes Caillaouas and Tramezaygues in the Pyrenees Mountains by Societé Hydro-Electrique du Midi. When flow is sufficient, the plant at the latter lake drives pumps to force water from Lassoula reservoir to the upper lake, any surplus power being delivered to a 60,000-v. transmission line connected to a distributing station at Loudonvielle. If power developed at Tramezaygues is insufficient to operate the pumps, power may be taken from the line, drawn from other parts of the system where load is below generating capacity. When power demands on the system are heavy, water stored in Lake Caillaouas is utilized through the plant at Lassoula to supplement the rest of the system.

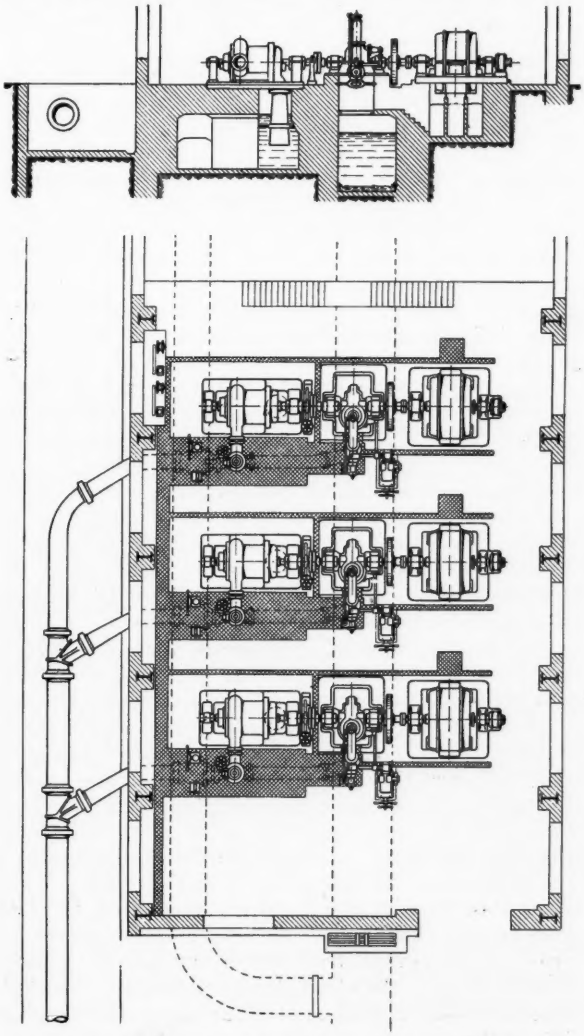


Fig. 1. Arrangement of Lassoula pumped storage plant

Total head between the lakes is 3000 ft., the Lassoula reservoir being midway, so as to use 1500 ft. and the plant at Lake Tramezaygues the other 1500 ft. The latter plant has three generating sets of 5500 kv-a. and two of 1500 kv-a., a total of 19,500 kv-a. At the Lassoula plant the installation is three five-stage centrifugal pumps; each delivers 4500 hp. and is connected by a clutch to a Pelton wheel of 5000 hp. and a motor-generator of 4500 kv-a. at 10,000 v., current being stepped up or down by 10,000-60,000 v. transformers. The pumps can operate over a range of 6670 g.p.m. at 1555 head to 8250 g.p.m. at 1322 ft. head according to conditions to be met. Pump clutches can be put on or off while the units are at rest, which meets all requirements, as pumps work only during certain flood seasons.

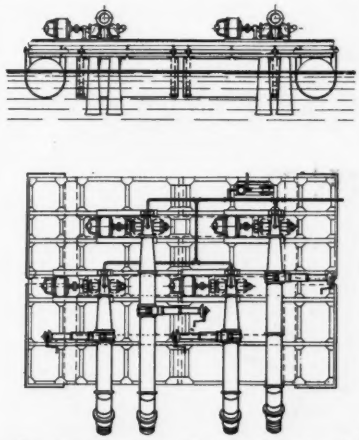


Fig. 2. Floating pumping plant for lowering lake level

Arrangement of the Lassoula plant is shown in Fig. 1, the pumps being at the left, Pelton wheels in the center and motor-generators at the right. Strainers and foot valves are omitted from pump suction pipes to keep suction head as small as possible, a hydraulically-controlled stop valve being placed in each delivery line to control the flow. This can be closed by hand for ordinary operation but, in case of failure of electrical supply it is closed automatically by hydroelectric control, time being adjusted so as to avoid water hammer. Total power to drive the three pumps is 13,500 hp. and total output when generating is 13,500 kv-a.

One interesting construction feature was the method of installing a new outlet from Lake Caillaouas. Since 1898 the lake has been used for irrigation with outlet at a level of 6990 ft. The dam was raised to

give a level of 7055 ft. (ultimately to be 7117 ft.) and it was desired to have the outlet tunnel at 6827 ft., in order to utilize more of the capacity of the lake through the water wheels at Lassoula. To drive the new tunnel by dry working, it was necessary to lower the lake level and two floating pumping plants were installed, Fig. 2, near the location of the new valve chamber, a vertical shaft sunk to the level of the bottom of the new outlet tunnel and several auxiliary tunnels run to this shaft, so that the floating pumps would pump against not more than 49 ft. head.

Each pump set had four Sulzer centrifugal pumps, each with capacity of 7400 g.p.m. against 49 ft. head at 975 r.p.m. Water pumped out was 2420 million gal., all utilized in the power plants below during the dry winter of 1931-2. The work was completed so that the flood water in 1932 again filled the lake. Each plant, weighing 55 t., was floated on 12 cylindrical tanks 5 ft. diam. by 13 ft. long, the platform being of rolled structural shapes. These pumping outfits, as well as the pumps in the Lassoula installation were furnished by Sulzer Bros. Ltd. of Winterthur, Switzerland, all work being planned and supervised by J. Leclerc du Sablon, director of the Hydro-Electric Co.

Oberhasli Development

A striking aerial view of the Grimsel Reservoir Lake belonging to the Oberhasli hydroelectric development near Meiringen in the Bernese Oberland, Switzerland. The photograph was made by Walter Mittelholzer, noted Swiss air pilot. The Grimsel lake has a surface of 27 million sq. ft. and a length of approximately 3½ miles. The Unteraar glacier is seen in the background

Welding Requirements *of* A.S.M.E. Code

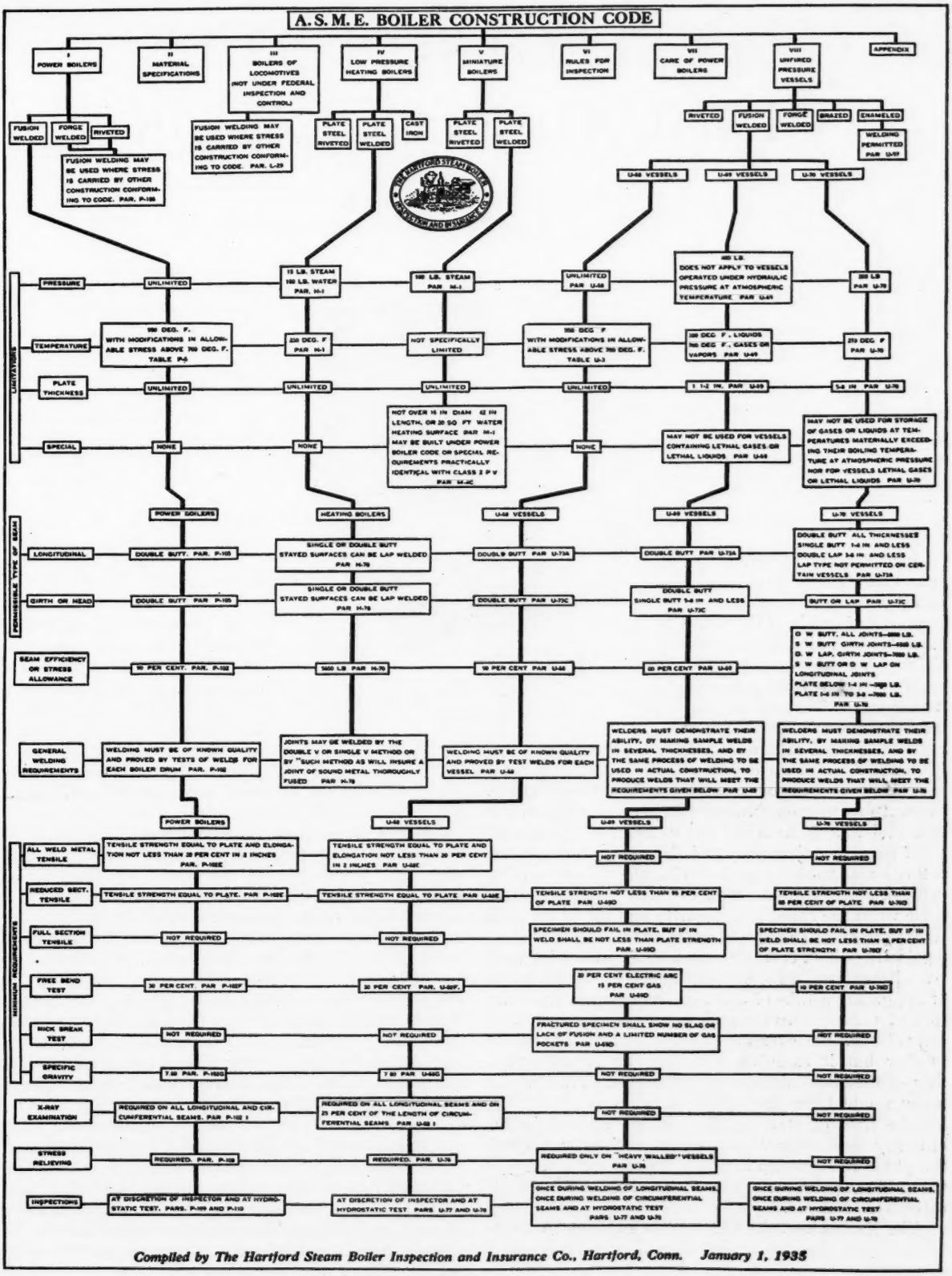
W. R. Halsey, Assistant Chief Engineer of the Boiler Division of the Hartford Steam Boiler Inspection & Insurance Co., Tells the A. W. S. of Chart Compiled to Show Scope of Boiler Code

WELDING REQUIREMENTS of the A.S.M.E. Boiler Code, which is subdivided into a number of sections, are different in each of the various sections and it is the purpose of the accompanying chart to make these differences clear. By following through the chart from top to bottom along the heavy guide lines, the limitations on, and requirements for, welding may be readily found. In addition to the information relating to welding, the chart also gives certain other limitations such as pressure, temperature and plate thickness, that are permitted. Information is also given as to the permissible type of seam that may be used, with the seam efficiency or stress allowance in each case.

The chart brings out an outstanding difference between the requirements for power boilers and U-68 vessels (formerly known as Class 1 vessels) and the requirements for U-69 and U-70 vessels (formerly known as Class 2 and Class 3 vessels, respectively). In the case of fusion-welded power boiler drums and fusion-welded U-68 vessels, the soundness of the seams must be determined by X-ray examinations and the physical properties of the welded joint must be determined by test of the weld for each vessel. On the other hand, in the case of U-69 and U-70 vessels, no X-ray examination or physical tests of the welding for each vessel are required. In lieu of such examination and test, it is required by the Code that the manufacturer decide upon a definite technique of welding and that the individual operators of the welding equipment make test welds in various thicknesses of plate under such technique of welding.

These welds are subjected to various tests as shown in the chart and, if the results are satisfactory, the operators who made them are permitted to weld on U-69 or U-70 vessels, as the case may be. Thus, it is assumed in the case of such vessels that if a definite technique of welding has been adopted and proved by test to give satisfactory results and, if the individual operators of the welding equipment have shown themselves capable of making welds under that technique that will meet Code requirements, the welding on any particular vessel under that technique and by those operators may be considered as satisfactory for the purpose intended.

There are, of course, many details appearing in the Code that it is impossible to bring out in a chart of this nature. Reference has been given, however, to the Code paragraph from which any specific requirement shown on the chart has been obtained, and reference should be made to such paragraph for complete information.

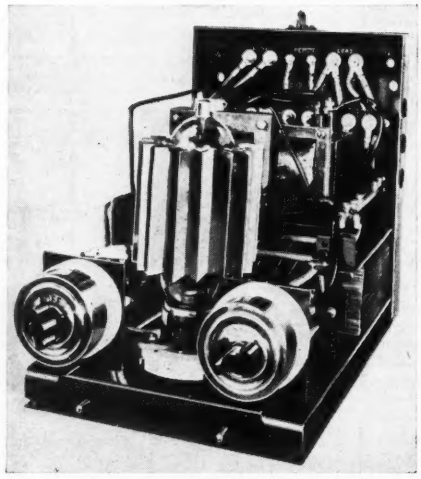

A.S.M.E. BOILER CONSTRUCTION CODE
I POWER BOILERS
II MATERIAL SPECIFICATIONS
III BOILERS OF LOCOMOTIVES (NOT UNDER FEDERAL INSPECTION AND CONTROL)
IV LOW PRESSURE HEATING BOILERS
V MINIATURE BOILERS
VI RULES FOR INSPECTION
VII CARE OF POWER BOILERS
VIII UNFIRED PRESSURE VESSELS
APPENDIX
FUSION WELDED
FORGE WELDED
RIVETED
FUSION WELDING MAY BE USED WHERE STRESS IS CARRIED BY OTHER CONSTRUCTION CONFORMING TO CODE. PAR. P-198
FUSION WELDING MAY BE USED WHERE STRESS IS CARRIED BY OTHER CONSTRUCTION CONFORMING TO CODE. PAR. L-29
PLATE STEEL RIVETED
PLATE STEEL WELDED
CAST IRON
PLATE STEEL RIVETED
PLATE STEEL WELDED
RIVETED
FUSION WELDED
FORGE WELDED
BRAZED
ENAMELED
WELDING PERMITTED PAR U-97
U-60 VESSELS
U-69 VESSELS
U-70 VESSELS
LIMITATIONS
PRESSURE
UNLIMITED
15 LB. STEAM 160 LB. WATER PAR. H-1
160 LB. STEAM PAR. M-1
UNLIMITED PAR U-68
400 LB. DOES NOT APPLY TO VESSELS OPERATED UNDER HYDRAULIC PRESSURE AT ATMOSPHERIC TEMPERATURE PAR U-69
300 LB PAR U-70
TEMPERATURE
700 DEG. F. WITH MODIFICATIONS IN ALLOWABLE STRESS ABOVE 700 DEG. F. TABLE P-6
210 DEG. F PAR H-1
NOT SPECIFICALLY LIMITED
750 DEG F WITH MODIFICATIONS IN ALLOWABLE STRESS ABOVE 700 DEG. F. TABLE U-3
300 DEG F. LIQUIDS 700 DEG F. GASES OR VAPORS PAR U-69
210 DEG F PAR U-70
PLATE THICKNESS
UNLIMITED
UNLIMITED
UNLIMITED
UNLIMITED
1 1-2 IN. PAR U-69
5-8 IN PAR U-70
SPECIAL
NONE
NONE
NOT OVER 16 IN DIAM 42 IN LENGTH, OR 20 SQ FT WATER HEATING SURFACE PAR H-1 MAY BE BUILT UNDER POWER BOILER CODE OR SPECIAL REQUIREMENTS PRACTICALLY IDENTICAL WITH CLASS 2 P V PAR M-2C
NONE
MAY NOT BE USED FOR VESSELS CONTAINING LETHAL GASES OR LETHAL LIQUIDS PAR U-69
MAY NOT BE USED FOR STORAGE OF GASES OR LIQUIDS AT TEMPERATURES MATERIALLY EXCEEDING THEIR BOILING TEMPERATURE AT ATMOSPHERIC PRESSURE NOR FOR VESSELS LETHAL GASES OR LETHAL LIQUIDS PAR U-70
POWER BOILERS
HEATING BOILERS
U-60 VESSELS
U-69 VESSELS
U-70 VESSELS
PERMISSIBLE TYPE OF SEAM
LONGITUDINAL
DOUBLE BUTT. PAR. P-105
SINGLE OR DOUBLE BUTT STAYED SURFACES CAN BE LAP WELDED PAR H-76
DOUBLE BUTT PAR U-73A
DOUBLE BUTT PAR U-73A
DOUBLE BUTT ALL THICKNESSES SINGLE BUTT 1-4 IN AND LESS DOUBLE LAP 3-8 IN AND LESS LAP TYPE NOT PERMITTED ON CERTAIN VESSELS PAR U-73A
GIRTH OR HEAD
DOUBLE BUTT PAR P-105
SINGLE OR DOUBLE BUTT STAYED SURFACES CAN BE LAP WELDED PAR H-76
DOUBLE BUTT PAR U-73C
DOUBLE BUTT SINGLE BUTT 1-4 IN AND LESS PAR U-73C
BUTT OR LAP PAR U-73C
SEAM EFFICIENCY OR STRESS ALLOWANCE
90 PER CENT. PAR. P-102
1400 LB PAR H-70
90 PER CENT PAR U-68
90 PER CENT PAR U-69
D W BUTT, ALL JOINTS—2000 LB.
S W BUTT GIRTH JOINTS—1600 LB.
D W LAP, GIRTH JOINTS—1200 LB.
S W BUTT OR D W LAP ON LONGITUDINAL JOINTS PLATE BELOW 1-4 IN —1250 LB. PLATE 1-4 IN TO 3-8 —1000 LB. PAR U-70
GENERAL WELDING REQUIREMENTS
WELDING MUST BE OF KNOWN QUALITY AND PROVED BY TESTS OF WELDS FOR EACH BOILER DRUM PAR. P-102
JOINTS MAY BE WELDED BY THE DOUBLE V OR SINGLE V METHOD OR BY "SUCH METHOD AS WILL INSURE A JOINT OF SOUND METAL THOROUGHLY FUSED PAR H-76
WELDING MUST BE OF KNOWN QUALITY AND PROVED BY TEST WELDS FOR EACH VESSEL PAR U-68
WELDERS MUST DEMONSTRATE THEIR ABILITY, BY MAKING SAMPLE WELDS IN SEVERAL THICKNESSES, AND BY THE SAME PROCESS OF WELDING TO BE USED IN ACTUAL CONSTRUCTION, TO PRODUCE WELDS THAT WILL MEET THE REQUIREMENTS GIVEN BELOW PAR U-69
WELDERS MUST DEMONSTRATE THEIR ABILITY, BY MAKING SAMPLE WELDS IN SEVERAL THICKNESSES, AND BY THE SAME PROCESS OF WELDING TO BE USED IN ACTUAL CONSTRUCTION, TO PRODUCE WELDS THAT WILL MEET THE REQUIREMENTS GIVEN BELOW PAR U-70
POWER BOILERS
U-60 VESSELS
U-69 VESSELS
U-70 VESSELS
MINIMUM REQUIREMENTS
ALL WELD METAL TENSILE
TENSILE STRENGTH EQUAL TO PLATE AND ELONGATION NOT LESS THAN 20 PER CENT IN 2 INCHES PAR. P-102E
TENSILE STRENGTH EQUAL TO PLATE AND ELONGATION NOT LESS THAN 20 PER CENT IN 2 INCHES PAR U-68E
NOT REQUIRED
NOT REQUIRED
REDUCED SECT. TENSILE
TENSILE STRENGTH EQUAL TO PLATE. PAR P-102E
TENSILE STRENGTH EQUAL TO PLATE PAR U-68E
TENSILE STRENGTH NOT LESS THAN 95 PER CENT OF PLATE PAR U-69D
TENSILE STRENGTH NOT LESS THAN 85 PER CENT OF PLATE PAR U-70D
FULL SECTION TENSILE
NOT REQUIRED
NOT REQUIRED
SPECIMEN SHOULD FAIL IN PLATE, BUT IF IN WELD SHALL BE NOT LESS THAN PLATE STRENGTH PAR U-69D
SPECIMEN SHOULD FAIL IN PLATE, BUT IF IN WELD SHALL BE NOT LESS THAN 95 PER CENT OF PLATE STRENGTH PAR U-70D
FREE BEND TEST
20 PER CENT. PAR P-102F
20 PER CENT PAR. U-68F.
20 PER CENT ELECTRIC ARC 15 PER CENT GAS PAR U-69D
10 PER CENT PAR U-70D
NICK BREAK TEST
NOT REQUIRED
NOT REQUIRED
FRACTURED SPECIMEN SHALL SHOW NO SLAG OR LACK OF FUSION AND A LIMITED NUMBER OF GAS POCKETS PAR U-69D
NOT REQUIRED
SPECIFIC GRAVITY
7.80 PAR. P-102G
7.80 PAR U-68G
NOT REQUIRED
NOT REQUIRED
X-RAY EXAMINATION
REQUIRED ON ALL LONGITUDINAL AND CIRCUMFERENTIAL SEAMS. PAR P-102 I
REQUIRED ON ALL LONGITUDINAL SEAMS AND ON 25 PER CENT OF THE LENGTH OF CIRCUMFERENTIAL SEAMS PAR U-68 I
NOT REQUIRED
NOT REQUIRED
STRESS RELIEVING
REQUIRED. PAR. P-109
REQUIRED. PAR. U-76
REQUIRED ONLY ON "HEAVY WALLED" VESSELS PAR U-76
NOT REQUIRED
INSPECTIONS
AT DISCRETION OF INSPECTOR AND AT HYDROSTATIC TEST. PARS. P-109 AND P-110
AT DISCRETION OF INSPECTOR AND AT HYDROSTATIC TEST PARS U-77 AND U-78
ONCE DURING WELDING OF LONGITUDINAL SEAMS, ONCE DURING WELDING OF CIRCUMFERENTIAL SEAMS AND AT HYDROSTATIC TEST PARS U-77 AND U-78
ONCE DURING WELDING OF LONGITUDINAL SEAMS, ONCE DURING WELDING OF CIRCUMFERENTIAL SEAMS AND AT HYDROSTATIC TEST PARS U-77 AND U-78
Compiled by The Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn. January 1, 1935

Graphic representation of the A.S.M.E. Boiler Code. Limitations, permissible service conditions and minimum requirements given briefly and, when necessary, reference to paragraphs in Code for more extended explanation

A Useful ELECTRON TUBE MANUAL REGULATOR

By PALMER H. CRAIG
Invex Corp. and Roller Smith Company

AMONG THE MANY applications of electronic devices for power circuits, the "Kathetron" manual voltage regulator is of considerable value and interest. It can be used for any alternating current circuit where it is desired to manipulate voltage, in fact, wherever alternating current rheostats, resistances, reactances, multi-step transformers and similar apparatus is ordinarily used.



Kathetron Manual Regulator
For 3 kv-a. 120 v., 25 to 95 per cent full load range

In order to understand the operation of this device it is necessary to know something about the principle of the Kathetron tube. This tube is essentially a hot cathode gas filled regulator tube of the grid controlled type. The ordinary gas filled grid controlled rectifier consists of a hot cathode usually in the form of an incandescent filament and intermediate grid and an anode. Current can pass only in one direction through such a tube and that is from the hot cathode to the anode.[1]

If an alternating current is impressed between the cathode and anode of such a tube, the grid remaining neutral, current will flow only during that part of the cycle when the cathode is negative and the anode positive. The output of the tube under these conditions is a pulsating direct current formed of the successive positive alternations of the impressed current. The purpose of the grid in a tube of this type is to control the duration of these positive impulses. Such a grid has no control over the current once the current has begun to flow but it exercises a control by retarding the flow of the positive pulse until some time after it normally would have started.

The time of starting the positive current in the ordinary grid controlled tubes is varied by varying the phase relationship between the current applied to the grid and the main current fastened between the cathode and anode.

The Kathetron tube bears a family resemblance to the ordinary grid controlled tubes in that it is also a hot cathode rectifier and has a control grid. In the Kathetron, however, instead of having the grid located inside of the bulb in electrical connection with the main anode-cathode circuit, it takes the form of a metal band externally surrounding the bulb. With this structure, the time permitted the positive current pulse to pass is varied by varying the potential applied to the grid without shifting the phase, something which evidently is more easy of accomplishment.

Briefly, then, the Kathetron is an instantaneous operating switch in which the time during which it remains closed may be varied by adjusting a voltage applied to an insulated band surrounding it. The action of this band or grid is to prevent the striking of the arc between the cathode and anode until some point later in the positive alternation of the anode-cathode voltage than would normally be the striking point. For example, if there were no grid the arc would strike as soon as the anode-cathode voltage reached the striking potential which is somewhere in the neighborhood of 12 to 15 v., but if a potential is applied to the grid this striking point can be delayed until later in the cycle. The exact time of striking being dependent upon the magnitude of the grid voltage and its phase relation in comparison with the anode-cathode voltage. In Kathetron controls this phase relationship is kept constant and the amplitude of the voltage on the grid is varied to produce complete control of the current which flows through the tube. Due to the fact that this grid requires practically no current for its operation, Kathetron tubes are well adapted to remote control of any kind.

For example, where it is desirable to vary the speed of small motors or vary the voltage applied to any distant point, whether this be an electro-chemical process, lamp dimming or other variable voltage application, the Kathetron manual control is excellently suited. The control can be as distant as desired from the point of application, up to several miles if necessary, and the leads which conduct the grid voltage from the small remote control to the point of appli-

[1]It must be understood when we speak of current here we mean flow of electrons. Unfortunately the ordinary conception of current flow (from positive to negative) is wrong when we consider the phenomena from an electron standpoint, but this conception is a hang-over from the days when the mechanism of the flow of electricity was not so well understood as it is today.

cation will handle only a few milliamperes at low voltage even when the control unit, which is placed near the controlled load, is handling powers of the nature of several hundred kilovolt amperes.

For example, in certain electric furnace applications, it is desirable to vary the voltage applied to the heater elements to rather accurate values to obtain the desired results. This control unit will accomplish this purpose either by remote control or by control at the

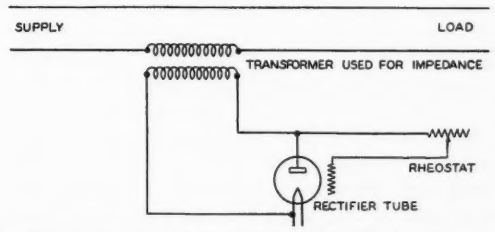


Fig. 1. Circuit showing the application of the Kathetron regulator for control of voltage below normal

furnace. The control as accomplished by the Kathetron unit is stepless and continuous and thus has an advantage over tapped transformers or tapped rheostats. Regulation of the output voltage to one-quarter volt or less is easily accomplished by this method. Other examples of its application are the adjustment of voltage which is applied to electro-chemical processes, the adjustment of voltage applied to welders

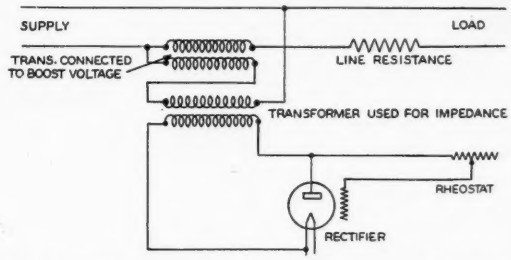


Fig. 2. Circuit showing regulator applied for varying voltage 50 per cent each way from normal

and the regulation of the voltage applied to the fields of large generators. In the latter case, the alternating current output of the regulator would be rectified and fed to the field instead of supplying the field from an exciter. In general, this form of manual regulation permits the adjustment of voltage at any remote point by means of a very small control carrying a negligible current.

A tube of this kind alone forms an elementary regulator in that if it is inserted in an alternating current line it will transmit to the outgoing circuit pulsating current whose magnitude may be controlled by varying the voltage applied to its grid. In this form, however, its application is limited. The odd shape of the outgoing pulse, varying as it necessarily does because of its consisting of a varying area formed by slicing off different amounts of each wave, is one objection. Another is the inherent characteristic of all rectifier tubes which limits the current carrying capacity to moderate values if the cost is to be kept down. Therefore, instead of applying the tube directly as a regulator by adjustably chopping off amounts of current wave passing through it, it is applied indirectly by means of a transformer as shown in Fig. 1.

Suppose a conventional transformer is inserted between the supply line and the load to be controlled, the primary of the transformer being in series with the line as shown. With the secondary of the transformer open, the impedance offered by the primary is evidently very high and cuts the current which can flow into the load circuit down to such a minimum as permitted by the characteristics of the transformer. If, however, the secondary of the transformer is short-circuited the impedance of the primary is reduced to a negligible amount and practically full line voltage becomes available at the load terminals. As shown in Fig. 1, the anode-cathode terminals of the Kathetron regulator are connected to the secondary of this impedance transformer; therefore, by varying the voltage supplied through a suitable miniature potential transformer to the Kathetron grid, the length of time that the secondary of the impedance transformer is short-circuited by the path through the Kathetron is varied and the current permitted to flow through the load varied to correspond. Since no booster characteristic is involved, its range is from slightly below normal voltage applied to the load down to 25 per cent or less of the normal.

The action in this circuit is not the same as with the saturable core reactor but involves rather the reflection of varying impedance from the tube back into the primary. The tube has a very high impedance when it is passing no current and a very low impedance after the arc has struck, so that its operation is similar to a short circuiting switch across the secondary of the impedance transformer.

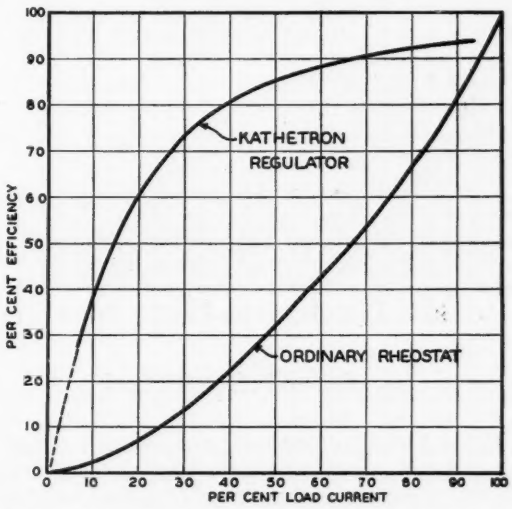


Fig. 3. Curves showing variation of efficiency with load of Kathetron regulator and ordinary rheostat

In another form, shown in Fig. 2, the Kathetron regulator is supplied so as to either boost or reduce the voltage applied from line to load over a range of about 50 per cent each way.

One of the main features of this control is its instantaneous response. There is no time lag between the settling of the control and the adjustment of voltage. This regulation occurs within one-half cycle.

Another outstanding feature is the fact that the load may be varied over extremely wide limits without appreciably affecting the voltage at the load.

For example, using the series impedance type of regulator one may set the output voltage at any desired point by means of the remote control and then vary the load throughout about 90 per cent of the capacity of the regulator without changing the voltage at the load appreciably. This is not true of any other form of manual voltage control unit. This point is of great importance where the load varies from time to time and it is desired to calibrate the control in terms of load voltage.

The efficiency of the Kathetron manual regulator is very high. The curves of Fig. 3 illustrate the way in which the efficiency varies with the load and also how it compares with the efficiency of other forms of manual regulators. The saving is quite marked when operating at reduced voltages on the load over long periods of time.

For example, by reference to the curves in Fig. 3, it can be seen that the efficiency of the Kathetron regulator when operating at 20 per cent of maximum load is 60 per cent as compared with the rheostat control, which is only 8 per cent at that load value; whereas, at 40 per cent load the Kathetron unit shows an efficiency of 82 per cent as compared with only 22 per cent for the resistance regulator.

The life of tubes is several thousand operating hours and a simple test will determine when the tube is reaching the end of its useful life. In the event of tube failure due to burn-out or any other cause, the service is not interrupted but the voltage is simply varied by the amount represented by the percentage buck or boost in that connection. A relay can be provided which will restore normal line voltage upon tube failure, but due to the long life of the tubes this is not usually required.

Regulators of this type can be supplied for almost any rating. Their design depends upon three factors: 1. Maximum total load to be controlled; 2. line voltage; 3. range in per cent of normal voltage.

Unified Power Production Evaluated in the South

By H. S. KNOWLTON

ADVANTAGES of operating generating plants on an interconnected basis in a given geographical area where coördinated service is feasible have often been illustrated as electric power networks have spread through many parts of the country. Perhaps the latest example of these benefits is afforded by the Commonwealth & Southern system, which has recently published an 89-page history and survey of its accomplishments. In the southern group of properties centering in Tennessee, Georgia, Alabama, South Carolina and Mississippi, there are 44 hydroelectric plants on 12 main rivers with a total installed generating capacity of 834,593 kw., and steam and internal combustion electric generating plants with a total installed capacity of 397,488 kw., which, plus 90,628 kw. available under lease or contract makes a total combined capacity of 1,322,709 kw. There are 9600 mi. of high-voltage transmission lines on these properties.

The entire generating and transmission system of the six companies concerned is operated as a unit, under a centralized control office and irrespective of state lines. As the generating plants are 66 per cent hydro, in some years it is unnecessary to operate the steam plants, and at all times the energy is pooled in the extensive grid system permitting surplus power in one state to be transferred to another where there is a shortage of water, or where it is desirable to store the energy in the great reservoirs located in three states. The steam plants are operated only when there is a shortage of water in the rivers, or in emergencies.

If these six companies were operated on an independent basis, they would be able to carry a totalized load of 803,000 kw., each company holding in reserve a sufficient capacity to take care of interruptions. Operated as an interconnected system, these plants are able to carry a load of 904,000 kw., or 964,000 kw. with the benefit of interconnections with neighboring companies, and in addition hold in reserve sufficient capacity to provide for interruptions. In addition to this gain of 101,000 kw. of prime capacity by unified operation, there is also a gain of 46,000 kw. of capacity due to the diversity of loads of the respective companies, making a total of 147,000 kw. of firm capacity created by reason of unified control. In the driest year of water flow these companies operating as independent units could produce 4,062,000,000 kw-hr. of energy, but operating under unified control this is increased to 4,571,000,000 kw-hr. Unified operation increases the entire capacity 15 to 20 per cent, and if evaluated, according to the system engineers, will show an annual operating saving in excess of $2,000,000.

To the engineer operating an industrial power plant, such figures reflect magnitudes far beyond his daily consideration; but it is well to remember that little more than a beginning has thus far been made in this country in evaluating the possible economies of industrial plant interconnection and sale of surplus industrial power to utilities. The field is well worth investigating much more widely, and the prospects are that the development of the vacuum tube for power transformation will ultimately stimulate this interchange in many areas. Potential economies of importance reside in many power plants which are within striking distance of one another, even if they are of small individual capacity in comparison with the utility stations.

TOTAL CAPACITY of water wheels at water-power plants in the United States on January 1, 1935, was 16,075,307 hp., an increase of 161,856 hp., or over 1 per cent, during the year, as reported by the U. S. Geological Survey.

Pennsylvania, with an increase of about 40,000 hp., and West Virginia, with an increase of 140,000 hp., are the only states that show any considerable increase in capacity of water wheels. Some states show a comparatively small increase, and others show a decrease, owing in part to the abandonment of plants and in part to the receipt of more accurate and up-to-date reports.

Correct Maintenance of COMMUTATORS

The Commutator of direct current motors and generators is the most vulnerable part of the machine. It therefore requires careful attention and only experienced operators should be entrusted with its maintenance.

By C. C. HERMANN

COMMUTATOR MAINTENANCE constitutes a considerable problem in plants where a large number of direct current motors and single phase equipment are used. Commuting of the current is a necessary function in order to conduct current from the generator in one direction and just as necessary to produce directional rotation in the motor. Since the current in the coils of the winding reverse in direction as the coil passes from one pole of the field to the next a counter e. m. f. is set up in the coil tending to oppose the reversal. Unless the brush is set just right there will occur some sparking at the commutator. This condition will be better understood from Fig. 1 which shows in diagrammatic form the field having a north and south pole, the armature having coils as shown, the commutator and the positive and negative brushes. It is observed that the coil "1-2-3", when in the position shown and with the armature running counter-

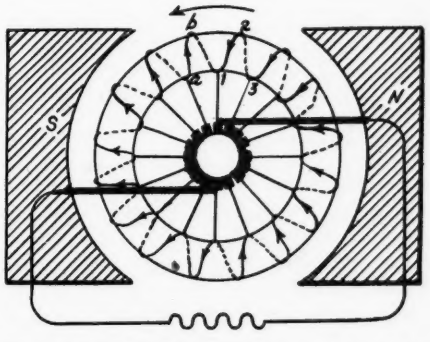


Fig. 1. Diagram showing direction of current in armature coils during commutation

clockwise, has a current induced in it flowing from right to left. However, as this coil leaves the flux path of the north pole and enters the flux path of the south pole the current changes in direction and tends to flow as shown at "a-b-1" in the reverse direction or from left to right. Each coil is connected to a segment of the commutator therefore the positive brush is resting on these particular segments at the instant of the reversal. Now since the self-induction of the coil tends to set up a counter e.m.f. which opposes the change in direction of the current there will appear a spark as this current jumps from the commutator bar to the end of the brush. This occurs at each point of commutation burning the bars and the brush.

To prevent this excessive sparking the brushes are shifted slightly ahead of the neutral point sufficient to permit the coil to move in the edge of the magnetic field of the next pole piece at just the instant when the counter current is at full strength so that the armature current will buck the counter current.

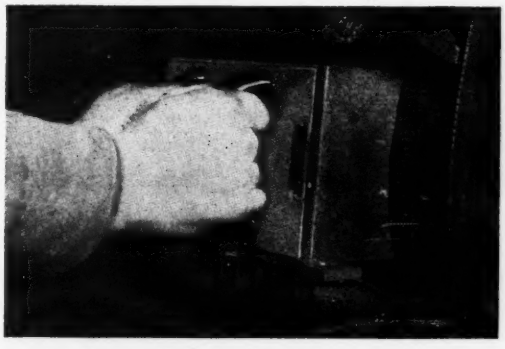


Fig. 2. Applying the commutator stone

The brush may be moved just enough so that no sparking will occur, however, in practice this is not practical since the self-induction changes with every change in strength of the current, therefore, the brush is shifted to the point which results in minimum sparking under the prevailing load condition.

Beside this commutating spark we have the mechanical faults in the commutator which cause sparking. Such faults may be flat spots on the commutator, the commutator being out of true and where some bars of the commutator are higher than others. The brushes may have rough faces or the brush springs have weakened or considerable wear has developed in the brush gear. These mechanical faults are usually easily corrected when once found.

Commutators must be kept smooth and round and the mica well undercut if efficient operation of the

machine is to obtain. To remove the commutator from the machine, which involves the removal of the entire rotor, is a huge task at times and involves closing down the machine for a considerable period of time as well as involving considerable labor charge for the work. Much of the maintenance work on the commutator may be accomplished without removal from the machine providing the proper maintenance equipment is at hand. The removal of large flat spots is best accomplished by turning down on a lathe after having removed the rotor from the machine, however, small flat spots, unevenness in the segment height and effects of excessive sparking may generally be removed by means of a commutator stone.

A commutator stone must be sufficiently large in surface area to more than cover the flat spot, preferably fifty per cent larger than the dimensions of the spot. It is quite obvious therefore that preventive maintenance is the best policy in connection with commutators. If the spot is detected soon enough a high priced maintenance job may be avoided. Not infrequently it is necessary to remove from $\frac{1}{16}$ in. to as much as $\frac{1}{8}$ in. of good commutating surface in order to remove a flat spot which, the last time it was noticed, was just a mere speck but now it has spread to very large dimensions. Flat spots grow rapidly and should be taken care of promptly.

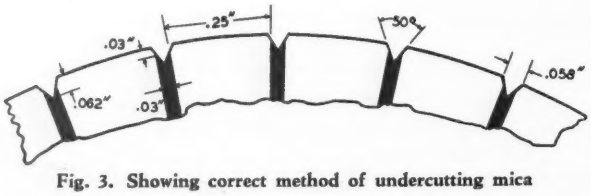


Fig. 3. Showing correct method of undercutting mica

Figure 2 shows the application of a commutator stone to the commutator of a large machine. The selection of the proper stone for the job at hand should be guided by the space available between the adjacent brush sets. Freedom of working space is necessary and if found advisable, due to the size of the flat spot and in order to use a stone at least fifty per cent larger than the spot, the adjacent brush set may be removed from the machine. When considerable copper is to be removed the use of a coarse stone is permissible for the first part of the cut changing to a finer stone after the surface has been cut down to remove the flat spot or results of burning and finally changing to a polishing stone. The entire time required to grind a commutator is about ten per cent of the time required to remove the armature from the machine, turn it and return it into service.

When grinding the commutator the machine must be run at full speed and, provided the stone holder is properly insulated, the work may progress while the machine is operating under normal voltage and full load. The stone must be held firmly against the copper with a pressure of from two to four pounds per square inch of surface. The stone must not be rocked but moved slowly from side to side to avoid ridges being cut in the stone and on the commutator. With heavy stones which are not so easily moved the change in grinding area may be made by lifting the stone away from the commutator after a few seconds of grinding, move it a small distance, say a quarter inch and let it down on the surface again. This action is repeated until the work is finished. Sometimes the stone will wear faster on one side than on the other. This is due to uneven pressure being applied. The stone is returned to its original condition by turning it occasionally. The matter of pressure is important. Sufficient pressure must be applied to obtain rapid cutting and uniform pressure must be applied to retain the entire face of the stone in action.

The grade of stone to be used depends upon the service encountered. Where there are a large number of commutators to maintain it is advisable to have several stones of different grade on hand. A good set may consist of 36 or 40 grain for jobs where considerable copper must be removed requiring fast cutting. A 80 or 90 grain will be found best for an all purpose stone as this grain will provide fairly fast cutting and result in a reasonably smooth surface. For smoother surface use 120 grain which is the same as No. 00 sandpaper and for still finer finish use 220 grain, the latter being used principally on sensitive radio equipment. The size of the stone, of course, will depend upon the size of the equipment intended to be serviced.

Before passing from this phase of the maintenance attention must be called to the necessity of proper cleaning of the commutator surface of all dirt and grease as this material if left on and the stone applied will result in the stone becoming clogged readily. Also the commutator must be examined closely before applying the stone to see if there are any loose segments in the assembly. Every one concerned with the turning of the commutator knows that a lot of trouble is encountered with loose segments. Under the action of the turning tool these segments will depress resulting in a low spot along the bar. Then under the action of centrifugal force the bar will move outward leaving the flat spot just behind the loose bar. When grinding with a stone this will not result, however, loose bars should be corrected by tightening up the commutator rings before grinding. While grinding stop occasionally to see that the commutator is bright around its entire circumference. Any dark sports are a clear indication that the grinding has not gone far enough.

If the commutator is eccentric, hand grinding will not remove the eccentricity except when the eccentricity is only slight and a fairly large stone is used. The proper procedure is to remove the armature from the machine and place it between centers where the defect may be removed by a grinding tool. The best shops use a pair of rectangular stones held in the tool post of the lathe and rotate the commutator during the grinding operation. The speed of rotation should be nearly that of the machine when in regular operation as then the same forces are functioning on the segments of the commutator.

Another important maintenance job in connection with commutators is the under-cutting of the mica. I have seen a good many undercutting jobs done which should have never been allowed. It takes skill and experience to do these tasks and one who is inexperienced should never be allowed to proceed without

proper and intelligent supervision. Give the average fellow a ground off hack saw blade and he will promptly go out and ruin an otherwise very fine commutator. Either the saw blade will be too thin resulting in a V cut in the mica with the top edges of the mica still projecting above the segments or the blade will be so wide that considerable metal will be removed from the segments at the top of the slot.

The function of under-cutting should be confined to the mica and the mica only. This requires that the blades should be the exact thickness corresponding with the width of the slot between the segments. This requires a set of special tools and such an investment is well worth while. The shop that goes along with inefficient and inadequate tools is penalizing the equipment. A properly made V slot is one which removes all the mica from the slot at a depth of at least equal to the thickness of the mica. In other words if the mica is 0.03 in. thick then the V slot should cut the edge of the mica and the side of the copper at a point 0.03 in. below the surface of the commutator. Figure 3 shows the correct dimensions for a V shaped cut on a commutator having bars ¼ in. thick and mica 0.03 in. thick. The angle of the V is 50 deg., the whole depth 0.062 in. and the width at the surface is 0.058 in. These cutters are made in diameter from ½ in. up to and including 1¼ in. and with included angles of 40, 50, 55, and 60 deg. The 40 deg. cutter is used for thin mica, the 50 deg. cutter for medium mica and the 60 deg. cutter for thick mica.

Fig. 4. Motor driven undercutting tool

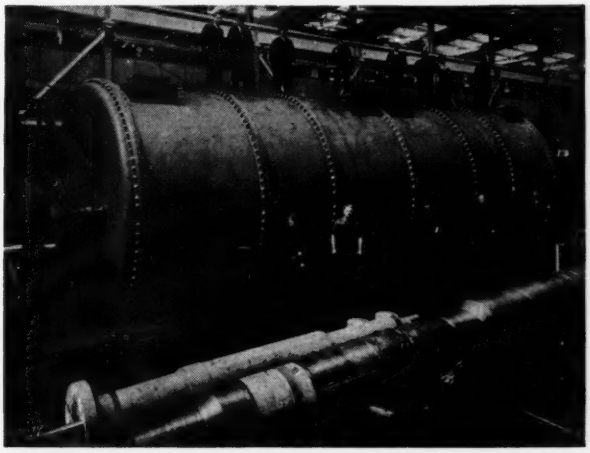
Another cutter used for this service is the U cutter. These are somewhat more popular than the V shaped cutters. They are made in diameters from ¼ in. up to and including 1¼ in. and in thicknesses varying from 10 to 45 thousandths of an inch.

Figure 4 shows a popular type of under-cutter in use in many shops. This equipment is intended to replace the old fashion under-cutting files so popular in many shops but eliminates the hard work so necessary with the old hand methods. The file is clamped in the vibrator shaft of the tool and a small motor, concealed in the frame of the tool vibrates the file back and forth performing the desired groove. This machine may be used to under-cut commutators without removal of the brush gear.

First Hydrogen-Cooled Frequency Changer

THE FIRST FREQUENCY changer in which are incorporated the advantages of operation in an atmosphere of hydrogen has been completed at the Schenectady works of the General Electric Company and will be installed at the Freemansburg, Pa., substation of the Pennsylvania Power & Light Corporation.

This unit will convert 60-cycle, three-phase power to 25-cycle, three-phase power for use at the Bethlehem



Steel Company's plant at Bethlehem, Pa. The motor of the new set is a 24-pole, 12,000 v., 300 r.p.m. machine rated at 23,500 kv-a. at 0.9 power factor. The generator has 10 poles, and at 6900 v., 0.9 power factor, will deliver 22,222 kv-a.

The use of hydrogen cooling in this new frequency changer is an outgrowth of the development of hydrogen-cooled synchronous condensers by General Electric during the last few years. Hydrogen is a more efficient cooling agent than air, permitting a saving in size for the same power rating. With hydrogen, the windage loss is about 10 per cent of that with air —this loss being nearly proportional to the density of the gas in which the machine operates. Electrically, the tendency for the formation of corona is eliminated by the use of hydrogen.

Hydrogen pressures of from one-half to one pound per square inch are maintained within the casing of the frequency changer by means of an automatic pressure regulator which takes make-up hydrogen, when required, from an auxiliary tank. It is necessary to hold only enough pressure to insure that any leakage which occurs will be outward, thus maintaining the purity of the hydrogen in which the machine runs.

Calculating Board Simplifies System Studies

By W. W. PARKER
Westinghouse Elec. & Mfg. Co.

Fig. 1. A modern a.c. calculating board

THE ALTERNATING CURRENT Calculating Board is proving of great value to the electrical industry by providing a quick and easy method of obtaining exact knowledge of system operating during normal, emergency and transient conditions. In the economical design and operation of the modern power system, problems are continually arising which require a careful analysis of the interconnected network for their satisfactory solution. Over a hundred such problems have been solved on the a.c. Board in East Pittsburgh since its installation five years ago. It is evident from a consideration of the record of operation that the board is of immense value to the industry.

Following are the number and types of studies which have been made:

(a) Voltage regulation and load control.....40
(b) Short circuit and relay.....30
(c) Stability (transient and steady state).....24
(d) Secondary distribution network design.....20
(e) Theoretical and special design..... 4

The range of application of the board and the diversity of the various problems cannot be fully appreciated from this classification alone. Some of these studies involved the complete design of a transmission and distribution network while others involved only the application of a single piece of equipment such as a transformer, circuit breaker or relay. Some of the more extensive studies required several weeks of board operation while the solution of the less complex problems were obtained in a few hours.

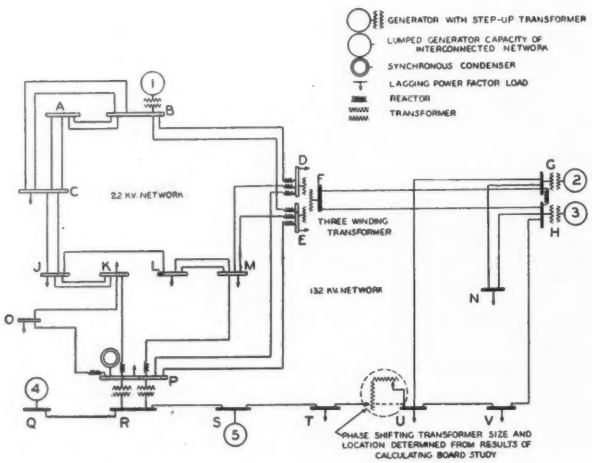

GENERATOR WITH STEP-UP TRANSFORMER
LUMPED GENERATOR CAPACITY OF INTERCONNECTED NETWORK
SYNCHRONOUS CONDENSER
LAGGING POWER FACTOR LOAD
REACTOR
TRANSFORMER
22 KV. NETWORK
THREE WINDING TRANSFORMER
132 KV. NETWORK
PHASE SHIFTING TRANSFORMER SIZE AND LOCATION DETERMINED FROM RESULTS OF CALCULATING BOARD STUDY

Fig. 2. Typical large power system network

In addition to the difference in type of problem another fact which emphasizes the range of application and the value of the board is that the above list includes studies of all voltage classes, from 220 volt secondary distribution and building networks to studies of the highest voltage systems yet contemplated.

The use of the board is not limited to any voltage, frequency, number of phases or any such characteristic of the system. Stability and associated problems can readily be solved in a "step-by-step" process in which the calculating board represents the rapidly changing system characteristics as a succession of steady state conditions. The board can be used wherever a problem concerns a network of impedance to which sine wave voltages are applied. When the system is so large that the number of compound parts, such as lines or generating points, exceeds the number of units available on any one board the method of equivalent networks is used if an exact reproduction of actual system conditions is required. In this method one section is set up in detail while the parts of the adjacent sections are "lumped" so as to use fewer circuits. An exact solution is possible by this method.

For practically all types of problems the board overall accuracy is such that the results obtained are well within the limits of the known factors in the actual system. Theoretical problems such as those which require reactor circuits with zero resistance of course have some slight error due to the small (less than 3 per cent) resistance component of the board reactors.

The above description of the scope of the board indicates that there is practically no problem involving network and circuit characteristics which cannot be studied on the bard. Whether an a.c. Calculating Board study is economically justified, that is whether it saves dollars and cents over any other method of arriving at a solution to a given problem, is another consideration. There are at least two distinct classes

of problems where the a.c. Calculating Board method has the advantage and can be proven to be the most economical.

First—when the complexity of the network, number of generating sources and other variables is such that a sufficiently accurate analytical solution is impossible. For certain problems a great many of today's interconnected systems are of this degree of complexity. A typical example is shown in Fig. 2. An a.c. Calculating Board study is the only reliable and practical method of obtaining accurate knowledge of the voltage distribution, current division, and power

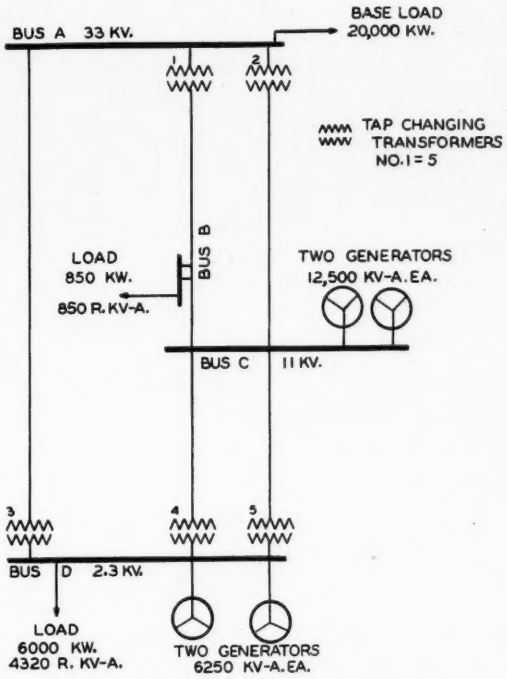


Fig. 3. Typical small problem for which many conditions are described

flow which will take place in such intricate networks.

Second—General problems where the use of the a.c. Calculating Board is the most economical method of solution. This class includes problems where a great many operating conditions or network configurations are required. For example take the case of a comparatively simple system which can be solved analytically for any one operating condition in a reasonable length of time. Analytically, almost as much time and labor is required for every new condition as for the initial solution, while on the calculating board all kinds of changes can be made quickly after the initial setup so only a matter of minutes is required for the solution of subsequent operating conditions. There is a distinct advantage in the use of the calculating board for all problems where several different schemes are to be tried or where, for some reason, a comparatively simple problem has many conditions for which the same network has to be studied. Figure 3 shows the diagram of such a network, where studies of the effect of changes in loads and changes in the tap settings of all the transformers made up the large number of conditions which justified the use of the board.

Polarized Light *as an* Aid *to* Design

Investigation of Proposed Designs Made Easy by Means of a Simple Polariscope Described to the A. W. S. Engineers. By E. W. P. Smith, Consulting Engineer, The Lincoln Electric Co., Cleveland, O.

DETERMINATION OF MAXIMUM STRESSES as they exist in actual or proposed designs is of vital importance. The determination of these stresses and their distribution may be done in several ways. One of the most convenient methods, the polariscope, is based upon the fact that when polarized light passes through an isotropic substance (equal properties in all directions) such as celluloid or bakelite, and that substance is stressed, the location of stress will appear colored when the rays are viewed through a suitable mechanism.

Such a mechanism for studying stresses may be very elaborate and costly or relatively simple and low in cost. The more elaborate method is the use of Nicol prisms and the lesser one by use of common glass. Light may be looked upon as a series of transverse vibrations similar to a stretched wire when struck. There is this difference, however, that light vibrates in all planes and the wire in a single plane. If the light can be made to vibrate in a single plane,

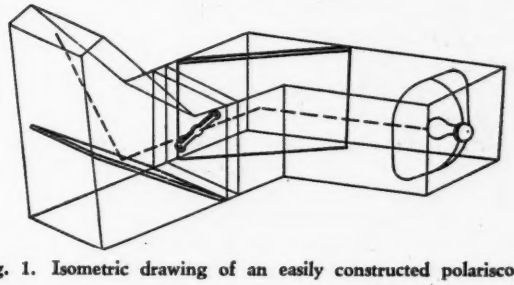


Fig. 1. Isometric drawing of an easily constructed polariscope

in the same manner as the wire, then the light is plane polarized.

Plane Polarization

It has been determined experimentally that certain crystals have the property of polarizing light into two rays with these resultant rays at right angles to each other. Iceland Spar is one. This is non-isotropic, that is, it has different properties in different directions. In general the action is as follows: Two crystals of Iceland Spar of suitable shape are cemented together by Canada Balsam. This is the Nicol prism. When common light strikes the crystal it is broken into two rays at right angles to each other, one vertical and one horizontal. The vertical plane of light travels faster and is deflected through a smaller angle than the horizontal which travels slower and is, therefore, deflected at a greater angle.

If the plane of the joint between the two crystals is at the proper angle, the vertical polarized ray will pass through and be deflected back parallel to its first direction. The other ray is deflected to the side and is absorbed in the blackened side of the enclosure. If the plane polarized light from this first prism is passed through a second prism in the same way, it will be unchanged. If the second prism is rotated 90 deg. the ray will be reflected to the side and light does not pass through. Materials such as celluloid and bakelite, when stressed, act exactly as Iceland Spar and a beam of light is broken into two plane polarized rays, which vibrate parallel to the two principal stresses at any point in the material.

If the beam strikes the material normal to its surface, so neither ray is deflected through any angle, one ray having higher velocity than the other, one

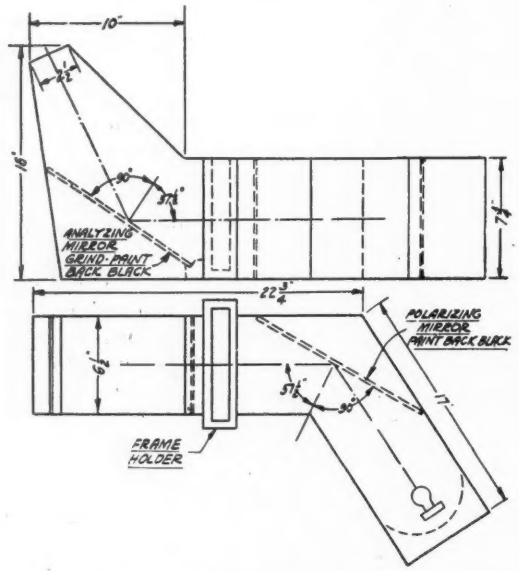


Fig. 2. Details of the polariscope. The angle 57½ deg. is correct for common glass

ray will emerge slightly ahead of the other. The amount one ray will emerge ahead of the other depends on the difference between the two principal stresses and is, therefore, proportional to the shear. If this difference is a number of full wave lengths, the two combine, resulting in a beam the same as the original. If the difference is an odd number of half wave lengths, this is not true and the resulting beam vibrates at right angles to the original.

Color Distribution Shows Stresses

If a sample to be studied is placed between two Nicol prisms, at right angles to each other, suitably lighted, and the difference in principal stresses is of such value as to cause rays to emerge one-half wave length apart, a light spot will appear on the screen. full wave length apart, a dark spot, one and a half wave lengths, a light spot, and so on. If light of all wave lengths is used, then the bands will show colors of the spectrum, instead of light and dark spots. The colors thus shown indicate stresses. These may be calculated, but for comparing designs and locating stress concentration points this is usually not necessary. A bunching of the color lines indicates stress concentration.

Another and less costly type of polariscope is the box type. It, as shown by Fig. 1, consists of a light source, such as a 7½ watt-point source of light, placed in a parabolic reflector (an automobile reflector cut to fit the box is excellent). The lamp should be located in the reflector so as to focus its rays. The polarizing mirror may consist of several sheets of thin glass, or a single piece, with the back painted black. This polarizer is located so that the rays of light strike it about 57½ deg. from normal. This angle is a function of the index of refraction and for the usual glass is approximately 57½ deg.

The analyzer is a single piece of glass, ground and painted black on the back, so located that the rays from the polarizer impinge at 57½ deg. from the normal. These rays are reflected through a suitable observation opening. Specimens made of bakelite or celluloid, cut to desired shape, are placed in a frame. This frame is so constructed that the specimens may be subjected to tension or other types of loading. The frame is inserted between the polarizer and analyzer and at right angles to the light rays.

Construction of Models

All of the above items are held in place by a box. This may be of any material, the inside being given a flat black finish. Where greater convenience of portability is desired the tye piece may be omitted and the box made in two parts, divided at the frame holder which is in this case omitted. The frame is held between these two parts when they are suitably placed. A convenient size is a box of 6½ by 7¾ in. outside dimensions, using ¼-in. plywood. This permits a good size model with reasonable dimensions of the box as in Fig. 2.

In addition to the polariscope itself, models and a suitable frame for holding these models are needed. It is advisable to make a frame which is suitable for testing both tension and bending specimens. First must come a study of pure tension. Two hooks are placed in the opposite corners of the frame and are so formed as to receive the model and permit its easy removal. They should be made of a type which will assure of the model being held straight and the center of pull exactly in line with the center of the model. This makes it easy to insert and remove the model, avoids bending and assures proper tension.

One of the hooks is stationary, while the other is fitted with screw or lever arrangement so it may be moved, and thus put the desired tension stress on the model. Lever arrangements have the advantage that weight may be used and the actual total tension on the specimen determined. The same thing can be done by putting an ordinary spring scale in series with the specimens, but this is not so conveniently done from a constructive viewpoint. The scale and parts necessary for holding it take up a great deal of room.

To make bending investigations of the simple beam type, it is necessary to provide two points of support and a load point. The load may be applied by direct

loading from a rod, threaded and inserted in the corner of the frame, or it may be applied by a saddle and the load applied as a pull or weight underneath the beam.

The frame may be made of any material provided it is strong enough. Plywood makes a light, easily handled frame. The supports for the beam should be slotted so as to make it easy to hold it in place. The degree of concentration of load or point of application may be governed by shape and size of the saddle.

Avoid Unnecessary Marks

The specimens or models may be made of celluloid or bakelite. For the polariscope as shown in the drawings a convenient thickness is 0.178 in. The material used must be of uniform thickness. This uniformity is exceedingly important, but the actual thickness is not, provided the specimens are properly proportioned so that they do not bend or crumple when loaded.

Another very important point is that the specimen be of uniform width except where the model dimensions call for different dimensions. And the center line of the specimen must be on the center line of the holes for the hooks. This is to avoid bending and consequently, inaccurate or misleading results. When making the specimens it is advisable to use a drill jig, as the drill is likely to drift throwing the sample out of line and introducing errors in the results or deductions.

Do not mark the surface of the material unless the mark is on a part which will be removed. For example, a center line scratched down the center of the sample would not be advisable. A line scribed as a limit, such as the edges of the sample and to which the material is cut, would be permissible, because when the material is cut, the line is removed. It must be kept in mind that if reasonable, informative results are to be obtained, disturbing or unknown conditions must be kept at a minimum; and, as will be pointed out later, an interruption of the surface is a most distrubing condition.

Before proceeding to make a number of samples, it is well to make up a simple, pure tension sample. An easy way to make these samples or models is to lay them out accurately on a piece of paper. Paste or glue this paper on the celluloid. Extend the center line of the sample so that when the jig is placed on it, the center line of jig, as marked on ends, can be easily lined up with the center line of the model.

Clamp the jig in position and drill the holes. Remove jig and cut out the model, smoothing the edges with a file or sandpaper. A saw with small blade, such as jig saw, is very helpful in cutting the model, particularly the more complicated designs.

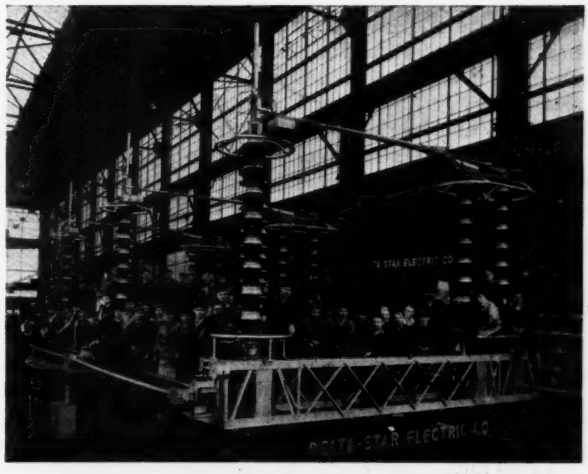
Testing is Simple

Place the model in the frame and without putting any stress on it place it in the polariscope. By looking in at the observation opening with light on, there will be found a reflection of the piece in the analyzer. If the polariscope has been properly assembled, this will be a rather dark gray and, while the image will be clear, it will not be brilliantly illuminated. Now put some tension on the sample and watch carefully the first color. This will, in the case of celluloid, be yellow. After yellow will come orange, then red, changing to violet, to blue, to green. Now increase the tension still more and the sample will turn yellow again. This is the beginning of the second series of colors and upon a further increase of tension the sample will go through the colors of the spectrum in the same order as before. In some cases the second series may be completed and the third started without damage to the model.

Upon removing the stress the colors will appear in reverse order. Very probably the sample will show some color. Perhaps the yellow or orange of the first series won't come out even with no load on the sample. This indicates that the sample is stressed. If the part has not been overstressed the color will disappear. The retention of color is dependent on a number of factors, such as quality and kind of material used, stress values, etc.

Upon the basis as given, above models of designs may be studied and the stress distribution analyzed. There are a few simple statements which will be helpful in laying out the preliminary design: There must be no abrupt interruption of the surfaces of the stress-carrying members; the smoother the surface the lower the ratio of maximum to average stress; the section may be viewed as a flume, carrying water and, wherever turbulence occurs, will be stress concentration.

Largest Disconnects *for* Boulder Dam



This is a view of one of the 287,000 v. disconnecting switches to be used on the 240,000 kw. line from Boulder Dam to Los Angeles. Sixteen of these motor operated switches will be used. This unit is pictured in the shops of the Delta-Star Electric Co. before shipment

Spring Servicing *of* Air Conditioning Systems

Proper Attention to Spring Servicing of the Air Conditioning Equipment Necessary for Best Results. By L. Gale Huggins, Commercial Engineer, Air Conditioning Dept. Westinghouse Electric & Mfg. Co.

COOLING AND REFRIGERATING PARTS of many air conditioning systems have been shut down during the winter and should be put in proper condition for the coming summer's work. If the refrigerating equipment received proper service when it was shut down last fall, spring servicing will be simplified as the parts of the system not used for winter air conditioning were properly protected during the winter. The following suggestions cover equipment which was shut down and disconnected for the winter period and also for systems which were merely allowed to stand without attention after the cooling season was completed last fall. All items, therefore, will not apply to all jobs.

Air Conditioning Unit

Before the equipment is started up, it should be carefully checked to make sure that it is in proper condition to start. The following operations should be performed on the air conditioning units: Remove filters and either replace with new filters or clean and recondition them; clean the heating and cooling coil surfaces using water and either a stiff wire brush or a flexible metal bristle brush particularly on the air inlet side of the coils as most of the dirt will be found there; clean and flush out the drip pan and drain connection to the unit making certain that the drain pipes are free of obstructions and that traps in the lines are clean.

Clean and lubricate the fan motors and if the motors are of the commutator type clean the commutators and brushes, replacing the latter if necessary. Check the fan operation and make sure that the air delivery is approximately correct. Operate the fans and if there is any unusual noise, squeaks or rattles they should be eliminated. Check the fresh air intake dampers, ducts and connections, clean and make sure that the dampers work properly and set the outlet grilles properly for summer operation. The setting of the outlet grilles or louvers often should be different for winter and summer to secure best results. This point should be rechecked after the system is running and supplying cool air.

After the above operations have been performed on the air conditioning units, the condensing unit should be prepared for operation by removing the protective cover and the unit should be cleaned by wiping with a rag moistened in gasoline or other solvent to remove the protective coating of oil applied to metal parts. The unit should then be wiped with a slightly oily rag so that some oil film is left on it. Clean the condenser of air cooled machines thoroughly, using a stiff brush or wire brush similar to that used for cleaning the evaporators, then make sure that any air ducts connected to the condenser are unobstructed. Oil the motor bearings in accordance with the motor manufacturer's instructions and care for any other points requiring lubrication. Check the quantity of oil in the compressor crankcase. If the level appears low do not add oil at this time, as it may have been pumped into the condenser when unit was "pumped down" last fall.

Clean the condenser water line strainer and regulating valve and if the valve seat looks worn replace it with a new seat obtained from the manufacturer as makeshift parts only encourage trouble. Check the water regulating valve to make sure that the valve stem has not stuck in the packing and repack if necessary. Reconnect the water inlet and outlet piping to the condenser if it was removed last fall then open the water shut-off valve and remove the key or handle to prevent water being accidentally shut off during the summer.

Purge air and non-condensable vapors from the condenser or liquid receiver, following manufacturer's instructions.

Examine the line starter contacts and either clean them up with a file or if they are burned appreciably, install new contacts obtained from the starter manufacturer. Replace fuses in control circuit only and try control equipment. Make and break contact at the room thermostat and the hand control switch. Be sure the motor starter is operating in response to the various control devices. Replace the power circuit fuses, start condensing unit momentarily and check the direction of rotation of compressor.

Examine and clean the refrigerant line strainer on the condensing unit and install pressure gages on the "high side" and "suction side" of the condensing unit. If the condensing unit is not provided with a permanent refrigerant sight flow indicator, install a service sight flow indicator for test purposes. In in-

stalling the sight flow gage, be sure to purge air out of the piping with the refrigerant while it is being installed. Open the liquid outlet valve on the liquid receiver tank and allow sufficient refrigerant to escape into the piping of the system to provide approximately 25 lb. pressure in the piping. Close this valve and carefully check all joints and connections on the condensing unit, on the refrigerant piping and on the air conditioning units. With Freon this may be done with a Halide test torch, with ammonia use a sulphur candle. If tests indicate piping is tight and free from leaks, open the liquid line valve completely allowing the refrigerant stored in the liquid receiver to escape into the system. Open the valve between the compressor and condenser and also the suction line valve. If pressure gages are installed on gage ports on these valves, be sure the gage ports are not closed when the valves are opened. All gages should now read the equalized pressure of the system. Start the air conditioning unit and the condensing unit and allow them to operate in a normal manner from 10 to 15 min. or until the system becomes stabilized in operation. During this initial running period, watch the compressor oil level carefully. If this level does not return to normal after a few minutes, investigate and add oil recommended by the manufacturer if required.

Observe the liquid flow indicator and if a solid stream of refrigerant is not secured, investigate and add refrigerant by the method recommended by the manufacturer of the condensing unit until a solid stream of refrigerant is secured. Then add the recommended surplus amount. Weigh and record the amount added at each operation. With the system in operation, examine all valves and strainers in the liquid line. If these are restricted, there will be a temperature change at the valve which can be readily detected by an experienced man. If such restrictions are found, clean the questionable strainer or make sure that the valve is open to give unrestricted flow of refrigerant.

Put a thermometer on the evaporator outlet at the point where the expansion valve bulb is attached to the suction line. Measure the temperature at this point and compare this with the temperature corresponding to the suction pressure. This should indicate approximately 10 deg. F. superheat. If not, carefully adjust the expansion valve 1/6 of a turn at a time until the proper reading is obtained.

Check the operation and setting of water valve and if the head pressure is not that desired, adjust the water regulating valve until the proper head pressure is obtained. After this adjustment is made, stop the condensing unit and make sure that the water regulating valve will shut tightly, completely stopping the flow of water. This will probably take from ½ to 2 min. after the condensing unit is shut down before the water is turned off entirely.

Check operation of the high pressure cut-out by cutting off the water to the unit and recording the head pressure at which the cut-out stops the machine. If the machine is not stopped at the recommended head pressure (approximately 200 lb. per sq. in. for Freon machines) the high pressure cut-out should be properly adjusted to stop the machine at this point. This high pressure cut-out is a safety device and its setting is important. With the system operating normally, cooling properly and a solid stream of refrigerant being obtained, the sight flow indicator should be removed, if one was installed specially for the test. In putting back the regular piping, the precautions regarding purging air out of the pipes, as outlined above, should be followed. After removing sight gage, restart the condensing unit and with the system running normally, again check all connections and joints. Remove all caution tags put on the machine for winter use.

When I Begin Operating

By M. BELL

EVERY marine engineer is familiar with the story of the superintendent who came below while the ship was in port. He was confronted with gleaming steel, polished brasswork and newly painted bulkheads. After a minute or so the engineer ventured to hope that he was satisfied with the looks of the engine room to which he replied: "To hell with the engine room, mister. Lift the plates and let me see the tank tops." If this was any one of the dozens of ships I know well, a merciful veil must be drawn over the rest of the story. Rust and corrosion are two of the greatest enemies plant men have to fight and it takes a good marine engineer to ferret them out. It is common practice to plaster paint and burnish brightwork at the strategic points where the manager's eye will strike and it is human nature to do so. It is in the darkest recesses of the power plant where the damage will be done and where the work should really be pushed. The damage may go on for years and remain unnoticed but, sooner or later, it will show up, often at the wrong time.

The writer recalls going around the manhole covers on a Scotch boiler upon which steam was being raised ready for sailing. With a 24-in. wrench and very little effort he twisted off a 1⅛-in. stud on one of the lower covers. Inspection showed that the studs of both lower covers were badly eaten away and the boiler had to be emptied, new studs fitted, and a tide lost.

The firemen, when cleaning fires, had piled their hot ashes against the lower doors and slaked them off with water before dumping them. This had hastened the destructive action and previous inspection of the studs must have been cursory.

Quite apart from the bad effect leaks have upon the surfaces they touch, it is bad practice to allow them, especially steam or condensate drips. It costs good money to turn water into steam and, unless this steam is kept in the system, there is a loss of efficiency and money which, although tiny in any one case, soon adds up considerably if there are many such leaks.

It is highly important for the engineer in charge to keep a careful check on the packing and jointing he uses. The great majority of these are excellent products and the principal reason so many fall down

is that they are used in the wrong places. On taking over a plant it is excellent practice to deputize one of the assistants to go around and list the size, diameter of shaft or spindle and service of every gland in the power plant. Then tabulate them and order a quantity of each different kind cut to ring size. It is economical to have the packing cut as stated for, although one loses slightly in flexibility, there is no wastage at all and anyone who is familiar with power plants knows how great this item is. Rings cut too long, too short or pieces left on the job through forgetfulness account for quite a little wastage.

Gaskets should also be cut carefully. It is better to keep the store always locked. When a man wishes to pack a gland let him bring the first two turns taken out to the engineer in charge. He can judge whether the gland needs repacking or refilling and can issue exactly the number of rings that are required.

Similarly, when a new gasket is needed, let the man be given a piece of jointing the correct diameter. If jointing is cut at the engine room store there is no loss and no wastage.

The above items may seem trivial but they mount up over a period to a considerable amount.

Lamps are another great source of loss. It should be a standard rule that no light should burn unnecessarily and, by this means, not only will power be saved but the life of the lamps will be longer. On a very large passenger vessel the writer made a tour one night after midnight and cut out over 1000 lights that had been left on unnecessarily. It was made a rule that a second offense of leaving lights on would be followed by dismissal and we saved both on current and new lamps the next year.

A Frequent Cause of Packing Failure

By V. W. WELLS*

IF YOU TOOK a failed packing out of a piece of equipment and found that it looked like the one illustrated in Fig. 1, what would you say had caused the packing to fail?

Many engineers would say that the packing failed because it was made of a poor piece of leather. While the leather in this case was not of the highest quality, it had nothing to do with the cause of failure.

To one who has viewed many failed packings the cause of the failure is very apparent. It was due to the fact that the inside follower plate did not properly grip the packing with the result that when the leather became wet and soft, the friction of the cylinder gradually stretched it and pulled it out from under the follower plate with the result shown.

As this excess leather was pulled out, the shape of the packing was distorted with the result that the lip eventually collapsed and permitted the pressure to pass by the packing. As the leather was pulled out

Fig. 1. Worn packing

on one side it naturally created a scarcity of leather on the other side; in other words, the packing was pulled tight around the edge of the follower plate and eventually wore through as shown.

This type of failure is not at all infrequent and unless proper steps are taken to correct the cause, the highest quality packing obtainable is liable to fail in the same installation. The proper solution is to cut concentric ribs on the inside follower plate which will grip the packing when the follower plate is screwed down tightly. These ribs should be rounded as shown in the cross section in Fig. 2 so that they will not cut

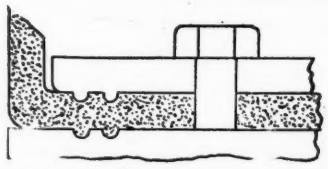


Fig. 2. Grooves in follower plate and piston hold packing in place

into the packing. The best practice is to cut corresponding grooves in the head of the cylinder or plunger on which the packing is mounted as shown in Fig. 2.

When a follower plate of this type is screwed down it grips the packing as shown in Fig. 3 and prevents it being distorted by the pressure or the friction of the cylinder.

Fig. 3. Used packing showing ridges formed by grooves

*Engineer, E. F. Houghton & Co.

As One Engineer to Another—

G. F. Continues with the Discussion of Problem Analysis. By G. F. WETZEL, M. E.

"YOU KNOW, G. F.," the Chief said, "I believe that if you will work along with me for a while I will really be able to work out a lot of problems. I am glad to find that I can look a problem right in the face and see what it is all about instead of getting scared of it. Suppose you give me some short examples using heat quantities so I can practice a little."

"That little speech, Chief, shows me that I was not wrong in believing that all you needed was a little help and encouragement. When a man awakens to the fact that he can do things his progress can't be stopped. The trouble with a lot of us is that we are just plain lazy, and won't make the effort that you have made to master the theory as well as the practice of your work. It might not be a bad idea to do a little practicing as you suggest.

"Here is some grist for your mill: How many B.t.u. will be required to heat a vat containing 3000 lb. of product with a specific heat of 0.65 from 70 deg. to 210 deg. F? Analyze each step."

"That's easy," the Chief replied. "Just apply the magic key, $H = C\,W\,(t_1 - t_2)$. In this case H will be the unkown, C the specific heat is 0.65, W, the weight is 3000 multiplied by, say, wait a minute, G. F., something is missing. How much will a gallon of product weigh?"

"I was just wondering if you were going to discover that I didn't give you the specific weight or the specific gravity. Assume a specific gravity of 0.8," I told him.

"W is 3000 multiplied by 0.8, but that isn't complete," the Chief reasoned. "Let's see, what does specific gravity mean? Oh, yes, that is the comparison with the weight of an equal volume of water, and water weighs 8.33 pounds to a gallon. Now I've got it.

$$H = 3000 \times 0.8 \times 8.33 \times 0.65 \times (210 - 70)$$

Checking back, $W = 3000 \times 0.8 \times 8.33$, the number of gallons multiplied by the specific gravity multiplied by the weight of a gallon of water—C is 0.65, and $(t_1 - t_2) = 210 - 70 = 140$. All O. K. Now to solve it."

$$H = 3000 \times 0.8 \times 0.65 \times 140 = 218{,}000 \text{ B.t.u.}$$

"Very good, Chief. I am glad to see that you have remembered the very important item of checking back. Here is another one."

"How many cubic feet of air can be raised in temperature from 60 deg. to 80 deg. by 500 B.t.u. if the average specific weight of the air is 0.075 lb. per cu. ft. You remember the specific heat of air is 0.24."

"I better look this over carefully to see if it is all there before I make any more wise cracks about how easy it is," was the Chief's comment. Then he went ahead with the analysis. "In this case the unknown factor in the basic equation is W, but the answer is wanted in cubic feet. How are you going to get cubic feet out of pounds, G. F.?"

"Is that nice, Chief? Just when I think you are going good you ask a baby question like that! If you have W pounds of air, and 0.075 lb. occupies one cubic foot, how many cubic feet will you have?" I asked him.

"I suppose it would be W/0.075," he replied. "I should have seen that in the first place."

"I will let V be the volume which is equal to W/0.075, or

$$W = 0.075\,V$$

"Then 0.075 V can be put in the equation in place of W so we will have

$$500 = 0.075\,V \times 0.24 \times (80 - 60)$$

Checking back, 500 is H; 0.75 V is W; 0.24 is C; and $(80 - 60)$ is $(t_1 - t_2)$. Yes, it is all there."

Now I have to get V off by itself, and get the numbers on the other side of the equation, which will give:

$$V = \frac{500}{0.075 \times 0.24 \times 20}$$

"This looks like a good chance to apply some simplifying," he continued. Divide 20 into 500 leaving 25, and cancel the 20 in the denominator,

$$V = \frac{25}{.075 \times .24} \text{ then divide by 25, leaving}$$

$$V = \frac{1}{.003 \times .24} = 1/.00072 = 100{,}000/72$$

$$V = 13{,}889 \text{ cu. ft.}$$

"By George," he exclaimed, "That did work out nicely, G. F."

"Yes, that one came pretty well, Chief. But you must remember," I reminded him, "that the figures you will run into in actual problems from practice do not always cancel out like that. But it is really surprising how many times they do lend themselves to this plan of saving arithmetic and time."

"Here is another angle in handling heat quantities that I want to call to your attention: Heat quantities are given in four general ways, (1) in B.t.u. direct, (2) the heat contained in, or given up by, a solid, liquid, or gas between certain temperature limits, (3) the heat in vapors or solids where the latent heat

of fusion or evaporation comes in, and (4) the heat transmitted through boiler shells or tubes, condenser tubes, building walls, etc., given usually in B.t.u. per square foot per hour per degree difference in temperature.

"Another type of problem that you will run into frequently involves mixtures of liquids or gases; for example one quantity of hot water mixed with a different quantity of cooler water, or hot air from heating coils mixing with cooler air recirculated, in a heating system, or air from a cooler mixed with by-passed air in an air-conditioning job. Here we will have our 'magic key' changed around somewhat; $CW_1 (t_1 - t_2) = CW_2 (t_3 - t_4)$. Here t_1 and t_2 will be the temperature difference through which W_1 is heated or cooled and t_3 and t_4 will likewise apply to W_2.

"Now I will give you another heat equation problem I was asked about the other day. In heating a swimming pool, the only way heat could be added was by continuously adding warm make-up water until the desired temperature was reached, allowing the overflow to go to waste. The recirculating system goes directly to the filters and the chlorinating equipment, with no provision for heating here. The question I was asked was: Would it be possible to calculate how much the level of the pool should be lowered by drawing water off through the drain in the bottom of the pool, so that when refilled up to the level of the over-flow trough by water from the heater, the temperature of the pool would be at the desired point? Here is the data. Put it down:

Temperature of warm water	100 deg.
Desired temperature of pool	78 deg.
Original temperature of pool	70 deg.
Size of pool	75 ft x 40 ft.
Volume of pool (to spill-trough)	17,570 cu. ft.

"During the week when the pool is in use, its temperature is maintained by adding warm water, but over the week-end when the pool is not being used its temperature will drop to about 70 deg. The actual temperature wanted is 76 deg., but to allow for evaporation losses while heating it up, heating the walls and floor, it was estimated that, figuring on a 78 deg. temperature, it would actually net about 76.

"Because of the many figures involved I would divide the problem into two parts:

"(1) How many B.t.u. will be given up by the entering warm water per inch of depth?

"(2) How many inches of water should be drawn off at the bottom of the pool at 70 deg. to lower the level enough to make room for the amount of warm water at 100 deg. required to bring the average temperature of the pool to 78 deg.?

"What would be the heat per inch of depth, Chief?" I asked him.

"That is easy, G. F." he answered promptly, "It is just the volume of water in a layer 1 in. thick, the size of the pool, given in pounds and multiplied by the temperature difference. Put down the figures I give you and see if I am right, in getting this into a definite value; 75x40 is the area, divide by 12 to get cubic feet in a 1 in. layer; multiply by 62.5 lb. per cu. ft.; multiply by the temperature drop (100 — 78) giving:

$$(75 \times 40 \times 62.5 \times 22) \div 12$$

equals 344,000 B.t.u. given up per inch of depth.

"I think you had better give me a suggestion for the next part, G. F.", the Chief continued.

So I helped him out with this hint, "If we let 'D' in inches be the depth we are after, and follow the principle we used before, of using the unknown quantity in our equation just as if we knew its value, then we can build up our equation on the basis that the heat available in the incoming warm water will just equal the heat received by the cool water left in the pool. The warm water temperature will drop from 100 to 78 deg., or 22 deg., and the cool water will rise in temperature from 70 to 78 deg.

"The available heat in the warm water will be $D \times 344{,}000$ B.t.u. The added heat in the cool water will be its weight multiplied by 8, the temperature increase in degrees. We don't know the weight of the cool water but we do know that it will be the full pool capacity minus the volume of the added warm water. The volume per inch of depth would be $75 \times 40 \div 12$ or 250 cu. ft. Therefore, the cool remainder will be $(17{,}570 - D \times 250)$, and the heat will be this multiplied by 62.5 to change volume in cubic feet to pounds, then by 8, the temperature rise. Now let me see what you have."

$$D \times 344{,}000 = (17{,}570 - D \times 250) \times 62.5 \times 8,$$

and its solution

$$344{,}000\,D = 17{,}570 \times 500 - D \times 250 \times 500$$
$$344\,D + 125\,D = 8755$$
$$469\,D = 8755$$
$$D = 18.7 \text{ in.}$$

"When you can go ahead and get results like that, Chief, it makes me feel that my time is well spent," I complimented him. "And now shall we look the problem over a little further? In this solution we balanced the heat input against the additional heat received, but it would be equally correct to say that the heat, say above 0 deg. in the pool after being warmed will exactly equal the heat on the same basis in the cool water plus the heat in the warm water; and to simplify the calculations, isn't it true that the weight will be exactly proportional to the depth? So we really did not need to find the actual heat quantities as the relative quantities in this case would do just as well. For example, the average depth of the pool will be $17{,}570 \div (75 \times 40)$ or 5.85 ft., or 70 in. Therefore the relative heat in the water after warming will be 70×78, and that will equal $D \times 100$, the heat above 0 deg. in D in. of water at 100 deg. plus $(70 - D) \times 70$, the heat above 0 deg. in the original water at 70 deg. So that the equation will read:

$$100\,D + (70 - D) \times 70 = 70 \times 78$$
$$100\,D - 70\,D = 70 \times 78 - 70 \times 70$$
$$30\,D = 70\,(78 - 70) = 560$$
$$D = 18.7 \text{ in.}$$

"Therefore, the engineer in charge of this pool would draw out enough water from the bottom drain so that the level would drop to 18.7 in. below the spill-over, or over-flow trough. Due to the normal spill-over from the use of the pool, the level of the water will usually be from 6 to 8 in. below the trough level, so that actually only about 10 in. of water will be drawn off."

Case Studies in Power Economics

Conducted By
ZUCE KOGAN
Kogan Industrial Service
Chicago, Illinois

ANNUAL POWER BILL REDUCED $2700 BY LOAD SCHEDULING

THAT A MINOR detail overlooked may oftentimes ruin the most elaborately prepared plan, is a truism, which requires no further explanation. There are too many cases in history that prove this. This is true both in finance, warfare, production and also true in the case of fuel and power consumption and their costs.

In this article we wish to illustrate a case where an item of insignificance brought about an increase in cost of electric power to the extent of $2700. A manufacturer of power transmission equipment decided, on account of a considerable drop in production and shorter hours, to operate under the so-called limited-hour rate offered by his electric utility. This rate calls for the curtailment of production during the hours of 4:30 p. m. to 7:30 p. m., normally called the "peak hours," in the months of November, December, January and February and if the power consumed during these hours is less than 25 per cent of the power used during any other time, there is a reduction in rate to the extent of 25 per cent.

Before applying for this rate the manufacturer made what he thought to be a thorough investigation of the amount of power he would require during the "peak hours." His maximum demand was in the order of 200 kw. Hence, he was entitled to 25 per cent of this demand, or to about 50 kw. during the "peak hours."

He found that he could stop practically all his production at about 4:15 p. m. allowing two or three lathes to operate later on to take care of emergency orders. Besides, he needed to run freight and passenger elevators; the passenger elevators for the office had to be operating until about 5:30 in the evening. He also found that he required some power for his boiler room, shipping room, office lights, etc.

Three blue print machines also had to be operated, each being equipped with a 15 amp., 220 v. d.c. arc lamp. From the connected load he estimated that his peak demand, that is the demand during the hours of 4:30 p. m. to 7:30 p. m. would be the following:

Boiler room, stoker, or sump pumps, lights	8 kw.
Elevators, freight and passenger	11 kw.
Office lights	10 kw.
Blue print machines	10 kw.
Shipping room lights	2 kw.
Miscellaneous equipment	5 kw.
TOTAL	46 kw.

After making this check-up he felt reasonably certain that the amount of power which he would require during the peak periods and which he thought he figured conservatively would lie within the limit of power allowed by the utility during the "peak hours" in the months of November, December, January and February.

He applied for this rate and during November, the first peak month, he was very careful to observe that only those enumerated above were in operation, everything else was shut tight. At the end of the month, however, when the bill was rendered he noticed to his surprise that he obtained a letter from the utility stating that he exceeded the provisions of this rate as he had used more than 25 per cent of the base load limit. Hence, he could not obtain the benefits of the rate and he had to resort to his original rate.

This manufacturer, after again checking the equipment and figuring the same way as he did before, was still convinced that there could not have been that much power used.

In order to verify his own conviction he called us in to make a general check-up of his plant.

After looking through the plant we found that he was too conservative in figuring the power on most of the items, but on one particular item, that is the arc lamps, he was not conservative enough, in fact, he was far off. The arc lamps of the blue print machines were supplied during the day continuously from a 100-kw. motor-generator set which was also used for running the d.c. motored cranes, and other d.c. motors. After all the production was down he still kept up the running of the 100-kw. motor-generator to supply these three arc lamps which required a total of only 10 kw. Of course, besides this 100-kw. motor-generator set he had to run a smaller motor-generator set to supply excitation current for this 100-kw. motor-generator set. This small motor-generator set had a capacity of 10 kw. which was connected to two synchronous motors driving compressors.

In order to show the manufacturer the actual load he had we first had a recording wattmeter installed on the main line. The recording meter showed that the maximum demand during the hours of 4:30 p.m. and 5:30 p. m. was around 55.5 kw., with very slight fluctuation. Then we connected the same meter on the circuit leading to the motor-generator set which also included the small excitation motor-generator set. From the chart of the meter we pointed out to the manufacturer that during the one hour run, even though the arc lamps were on several times during the

hour, the load of the arc lamp was hardly noticeable on the chart as the main load on the line consisted not of the 10 kw. required by the arc lamps of the blue print machines, but of the no-load losses of the motor-generator set and of the load of the excitation generator set.

The power supplied to the arc lamps was not equal to 10 kw., as their rating requires, but it amounted to slightly over 21 kw. Then, that which the manufacturer estimated to be 36 kw. (subtracting the 10 kw. for the arc lamps which he thought they would require) was only 34 kw., as the total load was actually 55 kw. and arc lamps were supplied through motor-generator sets with 21 kw.

Of course, once the cause of this high demand was known it was a simple matter to remedy. The manufacturer, however, in the meantime lost the right to operate under the cheaper electric rate for a whole year and he could not apply for this rate until the next November. This meant that by overlooking this detail he lost in the neighborhood of $225 per month or around $2700 per year.

When he again became eligible to try to operate under the cheaper rate he saw to it that the same thing did not occur. He purchased a small rebuilt motor-generator set of 15 kw. for about $285, and when the limited-hour period arrived he saw to it that the large motor-generator sets and the small excitation motor-generator set were shut down and that only the small 15-kw. motor-generator set supplied the arc lamps of the blue print machines. He has since been enjoying a saving in the order of $2700 per year.

Small Municipal Plant Has Low Water Rate

POWER PLANT IMPROVEMENTS in the municipal power plant at Anthony, Kans., carried out under the direction of Black and Veatch, consulting engineers of Kansas City, are practically completed. A new 750-kw. turbine was put in the line in the latter part of January and is now in regular service. The generating equipment now consists of the new 750-kw. unit, one 300-kw. and one 500-kw. unit. The boiler plant consists of one 300-hp., 4 drum bent tube boiler designed for 400 lb. working pressure and one 250-hp. straight tube boiler for 200 lb. working pressure.

The new turbine is designed to operate at either 190 lb. 100 deg. superheat or 275 lb., 200 deg. superheat and will carry full load under either steam condition. Regular operation of the plant will be at the higher steam pressure with the new unit in service, but when the new turbine is off the line the plant may be operated with the old turbines supplied preferably by the high pressure boiler, through a reducing valve and desuperheater.

This work, carried out by means of a PWA loan, is of interest because of its small size and high pressure operation and it is expected that the fuel savings, due to the increased efficiency of the new unit, will quickly pay for the improvements which cost about $65,000. The full load water rate of the new unit is 12.75 lb. per kw.-hr. in contrast to 17 lb. for the old units.

Oppose Sale of Surplus Power from Railway Plants

VIGOROUS OPPOSITION to a bill providing for the sale of surplus power to the city of Boston from generating plants of the Boston Elevated Railway featured a hearing on March 18 before the power and light committee of the Massachusetts Legislature. Representative T. J. Murphy of Boston, father of House Bill 1832, urged its passage on the ground that the deficit of the railway would be reduced considerably if surplus generating capacity could be marketed to the city. A special investigation by the state Department of Public Utilities some time ago indicated that about 130,000 kw. in total generating capacity was installed at the South Boston and Lincoln power stations. Maximum peak loads on the railway power stations have dropped from 93,800 kw. in 1931 to 75,900 kw. in part of 1933, according to the latest figures filed with the commission, giving a substantial surplus in capacity, although the alternating current production is at 25 cycles instead of 60 cycles as employed on the Boston Edison company's system. Various labor representatives favored the bill, but during the hearing it was brought out that the Elevated company's trustees have not endorsed the measure for sale of power to the city.

F. M. Ives, for the Boston Edison company, pointed out that if this kind of competition were allowed, the losses must be made up by increasing rates to other customers. He stated that underground conduits would be duplicated (transit systems pay no taxes on such conduits) and also said that the difficulties of voltage regulation and cost of changing equipment for 60-cycle service would be well-nigh insuperable. Sponsors of the bill had little conception of the economic aspects of trying to utilize 25-cycle surplus capacity on 60-cycle systems. The absence of endorsement for the scheme by the Elevated trustee management, Mr. Ives said, is convincing proof that the program should be abandoned. Sheldon E. Wardwell, counsel for various Massachusetts electric power companies, stated that it would be robbing Peter to pay Paul to discharge power plant operators in the Edison stations for the sake of giving more employment in the Elevated plants.

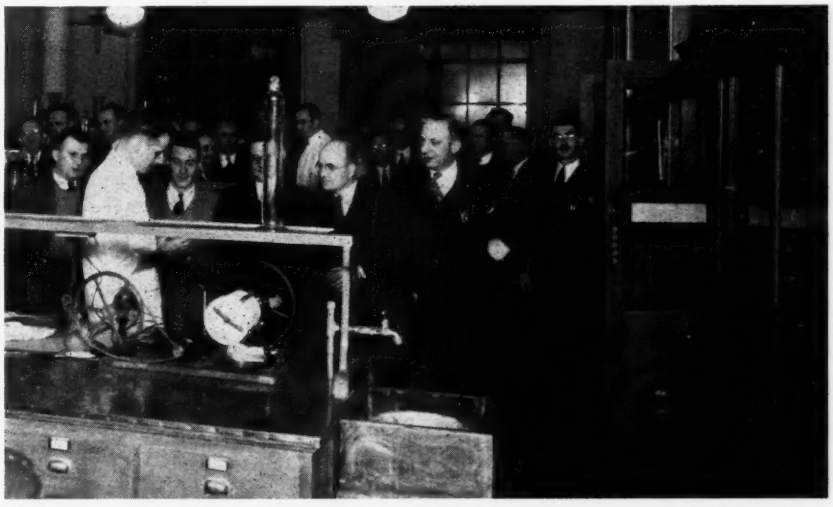
The sale of surplus power from the Boston Elevated stations was favored several years ago by the Massachusetts commission, but the plan fell into disfavor in view of its competitive and economic aspects until its revival at the present session.

BY THE Fescol electroplating process, coatings of nickel, chromium or other metals may be deposited on cast iron or steel, so firmly attached that they can be removed only by grinding. The deposit may be from 0.001 in. thick up to 0.01 in. for chromium or to 0.5 in. for nickel. Heating to 800 deg. C. has no effect on the adhesion of the deposit. By this means, prevention of corrosion and resistance to wear may be greatly increased.

Lecture Course *on* Water Treatment

Modern Chemistry Dealing Specifically with Water Correction and Laboratory Analysis Treated in Six Periods

DUE TO the interest shown by executives, chemists and engineers in the course of lectures on "The Chemistry of Water Correction" conducted by W. H. & L. D. Betz, Chemical Engineers, in their home city of Philadelphia, Pa., during the fall of 1934 with 60 in attendance and repeated in March and April of this year with an attendance averaging 100, the course is again being conducted, but the location is at the Robert Treat Hotel in Newark, N. J., for the convenience of those located in northern New Jersey and New York City. The course started on May 8 and will continue for six consecutive sessions on Wednesday evenings. No charge is made for attendance, admittance being by invitation.



During the consultation hour prior to the lecture, engineers are invited to discuss their special water treatment problems with the laboratory attendants and to receive instructions in making water analyses

During the course, particular stress and detailed attention is given to boiler feedwater chemistry. Each lecture is for a two-hour period, preceded by a conference hour at which time the number of those attending have the opportunity to learn water testing and discuss water problems with the water chemists and chemical engineers present. The subject matter is presented by chemical engineers who are authorities on their subjects, entirely from the standpoint of the application of scientific principles.

Following is a general outline of the lecture course:

LECTURE No. 1

a. General Chemistry. Chemical elements and symbols. Law of definite proportions, atoms, molecules and valence. Atomic weights.

b. Water Chemistry. Water, its composition and impurities. Classification of impurities. Dissolved solids, suspended solids, bacteria.

c. Water Analysis. Laboratory determinations of turbidity, suspended matter, organic matter, hardness —temporary and permanent.

LECTURE No. 2

a. General Chemistry. Shorthand method of writing chemical reactions. Types of equations and chemical reactions. Acids, bases and salts.

b. Water Chemistry. Mechanical methods for removal of suspended solids. Coagulation, sedimentation and filtration. Dissolved solids, hardness, sulfates, chlorides, alkalinity and silica.

c. Water Analysis. Alkalinities, chlorides.

LECTURE No. 3

a. General Chemistry. Ionization and electrical charges of particles. Crystalloids and colloids. Theories of colloidal chemistry.

b. Water Chemistry. Corrosion, oxygen, carbon dioxide. Theories of electrolytic corrosion. Methods of purification, external and internal. Lime and soda softeners—Zeolite softeners—Filter.

c. Water Analysis. pH Value.

LECTURE No. 4

a. General Chemistry. Sols and gels. Peptization and pectization—Viewing colloidal particles under ultra-microscope.

b. Water Chemistry. Internal methods. Soda ash, silicate of soda, phosphates, sodium aluminate, tannin and other inhibitors. Colloids, alkalinity in boiler waters. Surface tension, carry over and wet steam.

c. Water Analysis. Sulfates by the Burgess-Parr, benzidene hydrochloride, Betz-Hellige, and T.H.Q. (tetrahydroxyquinone) methods.

LECTURE No. 5

a. Water Chemistry. Scale formation; types, causes and effects. Method and procedure of blow down. Heat exchangers and continuous blow down. Economics of blow down. Caustic metal embrittlement.

b. Water Analysis. Iron—Calcium—Magnesium—Sicila—Calculation of Scaling factor. Percentage of blow down.

LECTURE No. 6

a. General. Industrial water problems. Correction of domestic waters. Brines and water in air conditioning units. Complete survey and analysis of a typical plant problem.

The Edison Electric Institute
meets at Atlantic City

ADVANCE HOTEL REGISTRATIONS indicate a heavy attendance at the Edison Electric Institute's Third Annual Convention to be held at Atlantic City, N. J., June 3 to 6. As was the case last year all meetings of the Convention will be held in the Traymore Hotel where a large hall is available for the general sessions and smaller rooms for the conference of the committees planning to hold meetings. No meetings of the five engineering committees are planned, but the Board of Trustees, the Operating Committee and perhaps several of the other committees will hold special meetings during the Convention period. The five general sessions of the Convention will be open to all those who wish to attend, regardless of membership in the Institute, registration at the desk being the only requirement for admission.

The program has been carefully designed to present subjects of paramount interest and value to the industry and its customers and stockholders and emphasis on the addresses and papers will be on those phases of utility operations and competition that are of direct public concern. Maximum economy in system design consistent with adequate and reliable service, government competition in its various ramifications, the present and potential effects of political harassment of the utilities, the building and holding of good will, successful utility sales promotion and other matters of vital importance will have predominant places on the program.

A number of prominent men from other fields will give points of view on the electrical industry and related subjects. Included in the guest speakers are Merle Thorpe, editor of The Nation's Business, Stewart McDonald, acting administrator of the Federal Housing Administration and Major Ezra B. Whitman, consulting Engineer of Baltimore and former chairman of the Maryland Public Service Commission. The Institute's officers who will speak at the convention are President Thomas N. McCarter, Vice President and Managing Director Bernard F. Weadock, and Treasurer Edward Reynolds, Jr.

First General Session

Beginning promptly at 10 o'clock Monday morning, June 3, the first general session will be devoted exclusively to sales and merchandising problems of the industry. H. P. J. Steinmetz, Public Service Electric & Gas Co., will report on the activities and progress of the Sales Committee, E.E.I. during the administrative year. Following this C. E. Michel, sales manager of the Union Electric Light & Power Co., St. Louis, and G. C. Estill, president, Florida Power & Light Co., will have "Sales Programs" as their general subject, discussing in particular the activities of their own companies in sales promotion. Stewart McDonald, acting administrator of the Federal Housing Administration will then tell of the advantages to be gained by the utility through the better housing program while the manufacturers' contribution to this session will be two addresses on subjects of unlimited potentialities for increasing consumption of electricity. The first, P. B. Zimmerman of the General Electric Co. will discuss the Electric Kitchen As a Load Builder and the second by Samuel G. Hibben, director of applied lighting, Westinghouse Lamp Co., will tell of new business horizons through vapor illuminants.

Second General Session

The second general session will begin at 2:30 p. m. when Bernard F. Weadock, vice president and managing director of the Institute, will present a summation of the findings of the Federal Trade Commission in its utility investigation. A paper by Frank McLaughlin, president, Puget Sound Power & Light Co., Seattle, on building good will will follow. That company has been notably successful in its public relations and merchandising programs and this contribution from one of the industry's most progressive younger executives will doubtless contain much sound information of practical value. J. F. Owens, president, Oklahoma Gas & Electric Company and W. H. Burke, Electric Bond & Share Co., will discuss Mr. McLaughlin's paper.

Development by theorists of construction costs purporting to show how cheaply power supply facilities could be built, has been a fruitful source for criticism of the utilities. In a paper dealing with the Effect of Service Standards of System Design, N. E. Funk, vice president, Philadelphia Electric Co., will discuss the fallacies of this school of theorists and define the major requirements of acceptable economic service. Paul M. Downing, vice president and general manager, Pacific Gas & Electric Co.; W. E. Mitchell, vice president and general manager, Georgia Power Co. and H. R. Woodrow, vice presiednt, Brooklyn Edison Co., Inc., are scheduled to discuss Mr. Funk's paper. A paper by Marion Penn, general manager, Public Service Electric & Gas Co. on Plant Modernization will deal primarily with the improvement of existing plants and show that a large percentage of present capacity can be brought to a high state of efficiency by various means and the session will be concluded with a discussion of Mr. Penn's paper by A. D. Bailey, Commonwealth Edison Co., A. H. Kehoe, The New York Edison Co., F. S. Clark, the Edison Electric Illuminating Co., and J. M. Drabelle, Iowa Electric Light & Power Co.

Third General Session

Beginning at 10 a. m. Tuesday morning with a report from Edward Reynolds, Jr., treasurer, on the fiances of the Institute, this session will be featured

by the presidential address of Mr. McCarter; addresses by Merle Thorpe, editor, The Nation's Business, and Jo. C. Guild, Jr., president, Tennessee Electric Power Co., and the report of Frank W. Smith, chairman of the Prize Awards Committee. The awards include the Charles A. Coffin Award; the H. M. Byllesby Prizes; the Forbes Prize; the A. L. Lindemann Prizes; the Thomas W. Martin Award; the James H. McGraw Prizes and the George A. Hughes Award.

Fourth General Session

This session will begin at 10 a. m. Wednesday morning. After the report of the nominating committee and the election of the Trustees of the Institute, Frank A. Newton, chairman of the Rate Research Committee will present the committee report covering the rate situation nationally and give specific data on the experience of different companies with the various types of promotional rates. Discussion from the floor will follow this report. Subsidized Electric Plants by H. W. Fuller, vice president, Byllesby Engineering & Management Corp., will deal largely with the recent trends in governmental competition and governmental encouragement of municipal plants.

An extensive study of the Tennessee Valley Authority, with particular reference to the rates of the TVA, the excess capacity in the TVA region, economic situation of possible consumers in the TVA area, has been made by Major Ezra B. Whitman, consulting engineer of Baltimore and former chairman of the Maryland Public Service Commission. His address on the TVA Rates and How They Were Made will present interesting information on this and other phases of TVA activities. The great emphasis now being placed by the government on rural electrification has created and circulated a tremendous amount of misinformation on this subject. Hudson W. Reed, The United Gas Improvement Co., is a member of a special committee that has done intensive research on rural electrification and at the request of certain governmental agencies has held several discussions with them on this problem. Mr. Reed's address will cover the basic information developed by the special committee and constitute an informal report on the conferences with the governmental agencies. H. C. Couch, president, Arkansas Power & Light Co.; Col. William Kelly, president, Buffalo, Niagara & Eastern Power Corp.; and E. C. Easter, Alabama Power Co., have been invited to discuss this paper.

The program for the fifth session, on Wednesday evening, to be featured by an address by a distinguished speaker of national reputation, has not been completed as this issue goes to press.

For the first 3 mo. of 1935, International Nickel Co. of Canada reports profit slightly less than for the same period of 1934, but an increase of cash in hand. Arrangements are in progress for retiring all of the mortgage debenture stock of Mono Nickel Co. on Aug. 1. Fields of application of nickel and nickel alloys of cast iron and steel are growing, cylinders for outboard motors and Diesel engines being among the important developments.

A. S. M. E.
Spring Meeting

THIS YEAR the Semi-Annual or Spring Meeting of the American Society of Mechanical Engineers will be held at the Hotel Gibson in Cincinnati, June 19 to 21. Nomination of candidates for the ensuing year are nominated at this meeting and the committee will be in session so that delegates can appear before it in support of candidates for office. The convention proper will be preceded by a meeting of the Council of the Society.

Details of the program are not yet completed, but the tentative program includes a total of 27 sessions to be held by the Society's Professional Divisions. The Fuel and Power Division will hold 4 sessions; Machine Shop Practice, 4; Graphic Arts, 5; Management, 3; Wood Industries, 2; Material Handling, 3; Iron and Steel, Education and Training, Railroad, Hydraulics, Process Industries, and Aeronautics Divisions will each hold a single session.

Power and Fuel Papers

Papers of particular interest to the power field are as follows:

Division of Load Among Generating Units, by J. E. Mulligan, of M.I.T.; Leakage of Steam Through Labyrinth Seals, by A. Egli, Westinghouse Elec. & Mfg. Co.; Steam Turbine Bearing Losses and Vacuum Corrections, by Linn Helander, Kansas State College; Principles Underlying Rational Solution of Automatic Control Problems, by S. D. Mitereff, Petersburg, Va.; Application Mutual Point Theory to Pipe Steam Calculation, by S. W. Spielvogel, Brooklyn Edison Co. and S. Kameros, New York Edison Co.

Rolling-In of Boiler Tubes, by F. F. Fisher and E. R. Cope, Detroit Edison Co.; A New Basis for the Rating of Roller Chain Drives, by G. M. Bartlett, Purdue University; Theory and Design of Pivoted Motor Drive, by R. R. Tatnall, J. E. Rhoads & Sons; Radiation Intensities and Heat Transfer by Radiation in Boiler Furnaces, by H. O. Croft and C. F. Schmarje, University of Iowa; A Simpler Type of Slag Furnace Bottom, by J. H. Strassburger, Wierton Steel Co.; Possibilities of Pulverized Coal for Small Boilers, by James W. Armour of the Riley Stoker Corp.

A Symposium on large hydraulic turbines including; the 115,000 hp. Boulder Dam Turbines, by W. M. White, Allis-Chalmers Mfg. Co.; Design and Construction of the Dneipestroy Units, by R. V. Terry and D. C. Moorhead, Newport News Shipbuilding & Dry Dock Co.; Wheeler Dam Propeller Turbines, by F. H. Rogers and R. E. B. Sharp, Baldwin-Southwark Corp. The Calvin W. Rice Memorial Lecture is to be delivered by Adolf Meyer of the Turbine Department of Brown Boveri Co., Baden, Switzerland.

An inspection trip to Norris Dam has been arranged jointly with the Society for the Promotion of Engineering Education. The trip will consist f a meeting, at Norris, Tenn., Saturday, June 22, arranged by the Knoxville Section in coöperation with the Tennessee Valley Authority.

Olson Rug Co. *Builds* New Power Plant

Chicago rug and carpet manufacturer builds industrial unit around power plant. Rugs, tile, flowers and walls, seasonal flowers, light colored uniforms for operators to make power plant a show spot

WITH A FIRM CONVICTION that American industry, by carrying on needed construction and improvements, can do much to break the depression, Walter Olson, president of the Olson Rug Co., Chicago, Ill., last year authorized the construction of a new industrial building and power plant, the third factory unit to be added since 1929. The new power plant, now nearing completion, will be an innovation, not only because it is located in the center of, and completely surrounded by, the massive, concrete building, but because it has enclosed re-enforced concrete coal and ash towers, eliminating old fashioned bunkers.

The entire design is in keeping with the high standard set by the factory building and well landscaped grounds, with its rock gardens, waterfountains and Martin colonies. The Steam Generator room will be equipped with the new flow-type, dustless coal conveyors, operated by means of the electric eye. The chutes and ducts will be painted aluminum. The steam generator room will be separated from the turbo-generator room by glass doors and partitions and the specially prepared floors will be covered with rugs. The light, tan enamel brick walls will have niches for ivy and seasonal flowers from the plant greenhouses. The operators will all wear light colored uniforms.

The power plant is 88 by 88 ft. square and 42 ft. basement to ceiling and will be in the central section of the entire factory. The new building will be 6 bays high, 6 bays wide and 10 bays long, each bay measuring approximately 500 sq. ft. floor area. This type of power plant will be, we believe, the first of its kind in the United States. The new plant will replace purchased power and a temporary boiler plant, consisting of four stoker-fired firebox boilers, totaling 650 hp., installed in 1928. There will be two steam generators, three turbo-generators, and the necessary auxiliaries. The coal tower will have an eight carload capacity and the ash tower a two carload capacity. The chimney will be 175 ft. high, 8 ft. in diam.

Most of the steam is used in the process for washing, sterilizing, dyeing and drying wool and carpets. The load varies greatly with peaks ranging up to 21,000 lb. of steam per hr. in the summer and 35,000 lb. per hr. in the winter. The electric power ranges from 25 kw. to 500 kw. with a consumption of approximately 100,000 to 150,000 kw. hr. per mo. The steam demand exceeds the electrical demand 80 per cent of the time.

From extensive engineering studies 275 lb. pressure with 200 deg. F. superheat was found to be the most economical to meet this plants' specific requirements.

There will be two 4250 sq. ft. steam generators, of the four drum water tube type, with water cooled bridgewalls, set in steel casings. The refractory will be backed up with 2 in. of magnesia block. The 15 ft. settings will give each unit a furnace volume of over 1000 cu. ft. each, and a maximum heat release of about 35,000 B.t.u. per cu. ft. Provision will be made for two additional units. The steam generators are fired by sprinkler type stokers, equipped with steam operated dump grates which discharge direct to special hoppers 8 ft. below the grate line. Ash is conveyed by steam jet conveyor into the ash tower. Draft will be furnished by two multiple type forced draft fans driven by induction motors. City water will be used for the boilers with a prepared chemical to be administered and a continuous blow-down system will be used to control concentration.

Two 1000-hp. steam turbines operating at 275 lb., 200 deg. superheat and exhausting at from zero to 25 lb. back pressure are installed for power generating purposes. Electrical characteristics are 220 v., 3 phase, 60 cycle, 750 kv.a.

A 75-kw. direct-connected turbo-generator will be installed to handle the night lighting load. In keeping with the character of the plant the turbine and stoker units will be trimmed with chromium plate. These turbines, with automatic back pressure control, will exhaust to the process lines. Steam beyond immediate process needs will be condensed in a 10,000 gal. hot water tank installed on the roof. Provision will also be made to install steam jet refrigeration and cooling water for employees. Drainage from the heating coils in this tank will be used for boiler feed purposes, hot water for employees and process requirements. The switchboard is of the dead front type completely equipped with instruments. Oil switches are used throughout and all cable is lead covered.

Weiss & Niestadt was the engineer and architect and John Small the consulting engineer. The general engineering surveys were carried out by the Olson Rug Co. engineering department, under the direction of Edmund Higginson, M. E., master mechanic and designer of practically all of the special process machinery used by the Olson Rug Co. for manufacturing floor coverings in the largest factory of the kind in the world.

Readers' Conference

Cutting Investment and Operating Charges

HERE IS SOMETHING designing engineers the world over have been striving and wishing for, for years—a power plant on which the investment charges are so low as to be almost ridiculous and having an operating cost approaching zero, if not less. Perhaps even more surprising than these broad statements is the fact that this remarkable plant is located not in or near any of our great industrial or metropolitan centers but far down in Winslow, Arkansas.

The photographs speak for themselves. No investment in building, refractories or insulation was required. The boiler setting was constructed of native stone with a cast iron rear arch culled from the scrap pile. The boiler which is fitted with safety valve, injector and blow down valve, is suspended from timber frames in such a manner as to impose no weight on the setting walls, which contain various peep holes for inspecting furnace conditions and for admitting secondary air. The steam lines are short and accessible and the pipe insulation by virtue of its absence is immune from injury.

Although of crude appearance this is far from being a poor job because all necessary steam is made at minimum cost. Both boiler and engine can be run by the men who operate the saws and, with free fuel which must be disposed of, thermal efficiency and steam plant gadgets are *de trop*.

Chicago, Ill. F. E. WERTHEIM.

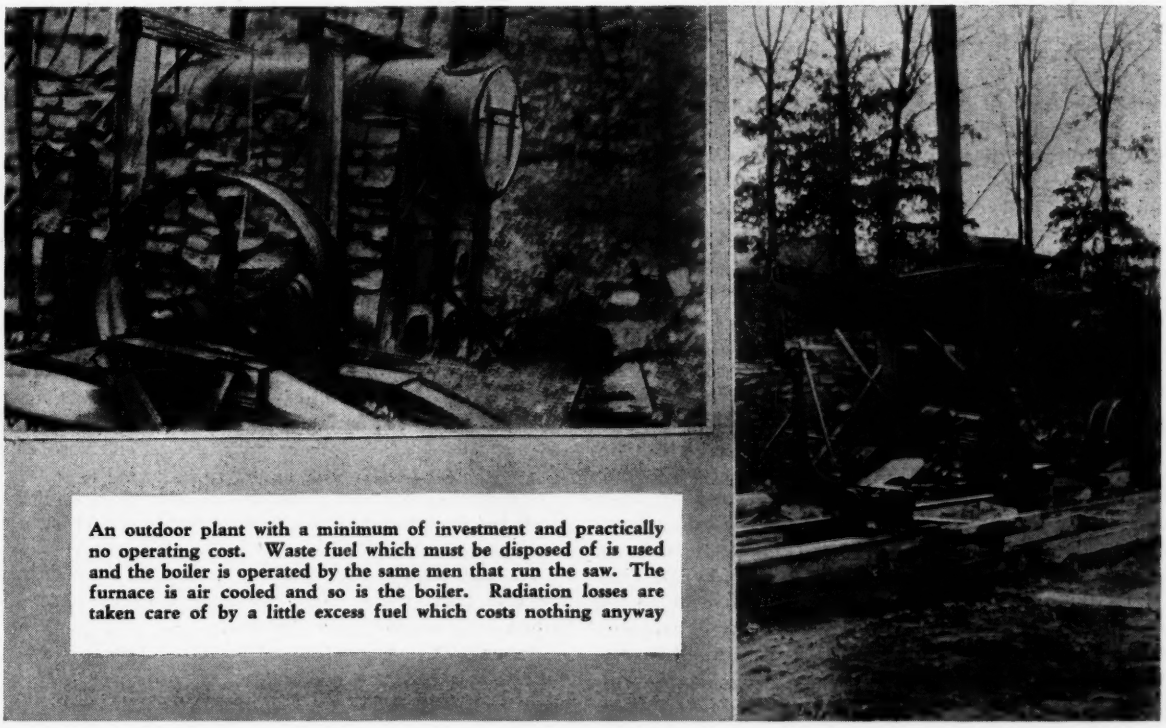
Feed Pump Circulating Lines

PROTECTION OF CENTRIFUGAL boiler feed pumps against overheating when operating with discharge line valves closed is important. Operation with no water flow through the pump often occurs when warming up before putting in service, or from action of feedwater regulating equipment under light or variable load conditions.

When a centrifugal pump is operated with its discharge valves closed, the churning action of the impellers tends to raise the temperature of the water in the pump casing. Should the temperature rise be too great, serious damage may result from over expansion of the pump parts or from vaporization of the water within the casing, causing seizure of those parts of the pump which depend upon water for lubrication. Vaporization often causes an interruption of the feedwater supply.

A widely used method of protecting boiler feed pumps from overheating is by the installation of a circulating line between the discharge of the pump and the feedwater heater. This circulating line insures a positive circulation of sufficient water through the pump to avoid an excessive temperature rise should stoppage of the normal flow occur.

It is often found that these circulating lines are installed much larger than is necessary. This is a wasteful practice. Just as much power is required to pump a given quantity of water through the circulat-



An outdoor plant with a minimum of investment and practically no operating cost. Waste fuel which must be disposed of is used and the boiler is operated by the same men that run the saw. The furnace is air cooled and so is the boiler. Radiation losses are taken care of by a little excess fuel which costs nothing anyway

ing line as is required to pump the same quantity of water into the boiler. The possibility of installing too large a line is particularly acute with pumps discharging against high feed line pressures.

In one instance, a circulating line consisting of a short length of ½ in. pipe discharging into a 1 in. circulating header was installed on a turbine driven boiler feed pump having a capacity of 200,000 lb. per hr. against a discharge pressure of 550 lb. Tests revealed 35,000 lb. per hr. flow through this line to the feed-water heater.

Based on the characteristic curve of the pump, the excess power consumption necessary to circulate this quantity of water was 40 hp. at normal operating load. This additional load on the turbine increased its steam consumption 880 lb. per hr. Inasmuch as the turbine exhausted into the feedwater heater, and bleeder steam from the main units was available for feedwater heating, the additional exhaust resulted in an appreciable waste. An orifice installed in this circulating line to reduce the flow to 10,000 lb. per hr. effected a considerable saving.

A convenient method for the approximation of the quantity of circulating water in pounds per hour necessary for the protection of boiler feed pumps is by the formula

$$\text{Hp. required against closed discharge valve} \times 2546 \over \text{Allowable temperature rise}$$

This formula is based on the fact that neglecting radiation and friction losses in bearings and stuffing boxes, all of the power input of the pump, when operating against a closed discharge valve, is converted into heat by the churning action of the pump impellers.

The allowable temperature rise will vary with each individual installation, depending upon the design of the pump and the positive static head on the pump suction.

It is the writer's personal experience that the allowable temperature rise should not exceed 10 deg. F. in the majority of cases where well designed centrifugal boiler feed pump installations are handling water from open feedwater heaters at temperatures above 212 deg. F. Where the static head on the pump suction is low, a lower temperature rise may be necessary if vaporization of the water in the pump casing is to be avoided.

Waynesboro, Va. S. H. COLEMAN.

Study in Expansion

IN ORDINARY FIGURING, three decimal places are sufficient for the average engineer and he frowns, quite peevishly, at four or five places. But in figuring expansions, especially of steam lines, at least seven places should rule.

The engineer who frowns at four decimal places would, under no conditions, install a heating coil as void of expansion liberties as that in Fig. 1B. He would design and build it as in Fig. 1A, provided he could not get around a suitable corner for expansion.

But when admitted experts lay out a line of husky steam pipe 300 or 400 ft. long, spend much midnight oil (probably at the company's expense), and then fall far short of the necessary allowance, something is decidedly wrong.

Taking for a coefficient of expansion 0.000,012,1, a line of steam pipe under 10 lb. gage pressure, and a tunnel temperature of 100 deg. F., 300 ft. long, the pipe theoretically should grow: $300 \times 12 \times (240 - 100) \times 0.000,012,1 = 6.098$ in.

As a matter of fact, it did so.

But, a make-up from a 500 deg. F. line spilled into the 10 lb. line, before it entered the tunnel, so the story went: $300 \times 12 \times (400 - 100) \times 0.000,012,1 = 13.06$ in.

And it was even so.

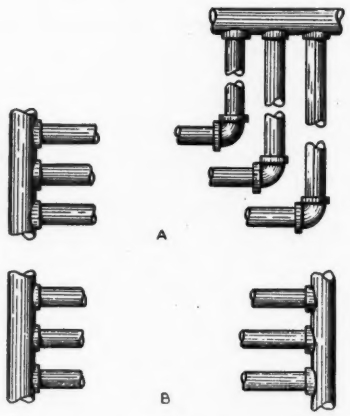


Fig. 1. Correct and incorrect design of manifold heating coil

If corrugated expansion joints are used, which was the case, it would seem that the proper method of installation, to insure best results, would be to pull the fittings together with long drag bolts (Figs. 3 and 4).

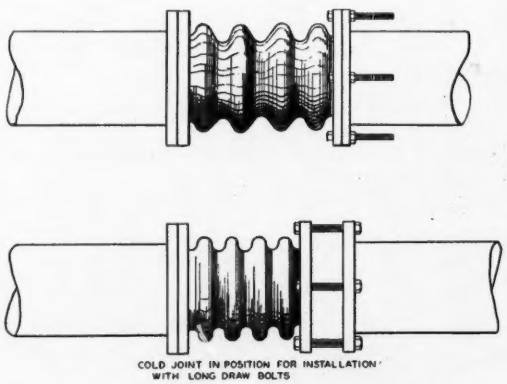


Fig. 2. Properly installed an expansion joint is subjected to very little expansion stress when in normal operation

By assembling the pipe and joints, with no pull, all of the expansion tends to push the joints so tightly together that distress is sure to follow. It did.

By the way, a thermometer well was tapped into the line from which the true temperatures were obtained by a standard instrument.

Somebody has said that a little education is dangerous; so is a little mathematics.

New York City. C. W. PETERS..

Results of Knowing "What" and "Why"

ON THE FRONT cover page of the January, 1935, issue of Power Plant Engineering, we see a very fine and interesting picture with the explanation "Instrument board showing 'what' and 'why' of combustion conditions at River Rouge power plant of the Ford Motor Company." This picture illustrates to any engineer, who has followed through the pages of Power Plant Engineering, the great advances made in the methods of firing or combustion employed at present and those in vogue not so many years in the past and I am sorry to state in all too many cases at present. Today the up-to-date plant uses methods and instruments to extract, as far as possible, every available B.t.u. from the fuel best fitted to their requirements.

Only a generation ago, a steam gage, water glass, and occasionally a high-low water alarm, usually inoperative, were considered the essential standard equipment. Once in a while a damper regulator of the "wide open—tight shut" variety were encountered but usually stack dampers were hand operated, if at all and a draft gage of any kind was a plaything for the use of "another one of those white collar nuts." The fireman of the "strong back and weak mind" variety who could "keep her hot" regardless of the quantity of smoke which rolled from the stack was "cock of the walk" in whatever plant he chose to honor by deigning to stop long enough to "show them how it was done."

Fuel was cheap and men cheaper. Few engineers even knew the rudiments of combustion and many cared less. Then about 1917 a gradual or rather a rude awakening took place when first the U. S. Geological Survey and then the Fuel Administration took charge of the fuel situation and plants which were not included in the preferred industry list got rated as to fuel requirements according to their efficiency as a whole, as nearly as could be done from inspection by the Government fuel inspectors. Many a plant got more than its just desserts as to rating, because no man, no matter how conservative, could find out in the brief time at his disposal, just how inefficient the operating methods were.

These studies, however, showed up a very grave condition of fuel waste in the steam generating plants of the country and aroused an interest in better combustion methods. Many of the larger plants had gone into this before that time, but it jarred up the small and medium sized plants to at least a partial realization of the wasteful methods prevalent. Schools of Combustion were organized and many men took advantage of them, while others, not able to attend these, took to books on the subject or correspondence courses. The general effect was for the better and what strides have been made are only too well illustrated by reading in the pages of this magazine of plants which now are producing a kilowatt-hour on a pound of coal and less, where not so many years ago a plant producing a kilowatt-hour with an average of 5 lb. was considered to be fairly economical.

Today the general run of engineers have been brought to the realization that fuel means capital invested and must be treated as such instead of a lot of chunks of screening which must be burned in any manner possible to produce results. It's not how many tons you can get through a furnace any more, but how much useful work can be produced from the B.t.u.'s expended. With this realization ended the reign of the "strong back and weak mind" and the man who does not improve his knowledge along this line and all others pertaining to the profession of engineering with what is offered today through the trade journals, public libraries and other sources available, should either get busy or get out.

Of course there are still some concerns that are too conservative to make any changes in equipment or furnish any instruments for the engineer's use in trying to save money for them. For such there is little hope of improvement, but for the man who knows his "what" and "why" the opportunities are almost unlimited and especially in plants where results must be obtained with equipment that is still serviceable yet far from being modern. Occasionally the overhauling and adjustment of equipment already installed, elimination of valve leaks, new gaskets in flanged joints, overhauling leaking traps, utilization of hot water and exhaust steam going to waste, and checking up on the steam used in process work and heating system will give a return in savings, almost unbelievable. On the other hand, what can be expected where there are draft controls, CO_2 and stack temperature records and boiler output indicators and feedwater recording instruments all out of order and in that condition for some time past because "it is too much trouble to keep in working order?" So when such workmen are eliminated on account of being inefficient, who primarily is to blame? So for his own protection and peace of mind, as well as the benefit accruing to the owners, the engineer should know and practice the "what" and "why" of the power plant.

Superior, Wis. FRED S. RUTLEDGE.

Bending of Belts and Belt Life

I READ with much interest C. O. Mitchell's criticism on page 130 of the February number of Power Plant Engineering concerning my article which appeared in the September issue on this subject of bending of belts.

Unfortunately, however, I am obliged to disagree with a number of Mr. Mitchell's statements for reasons which I shall endeavor to explain:

1. There is no such thing as absorbing a belt bend in "more free belt length." For instance, Mr. Mitchell incorrectly states: "But this elongation in a given belt length, say XY, is absorbed by more free belt length in Fig. 3 than in Fig. 4." The theory of stresses and strains in beams is based upon the given section. The length of the beam does not enter at all. Stresses and strains are not "absorbed by length." Stresses and strains in belts due to bending are computed in precisely the same way as in the computation of wood, steel, rubber, or other beams.

2. Referring to Mr. Mitchell's Fig. 3, he shows a length of curved belt embracing about 30 deg. around the center "A." The stresses in the fibers of that belt will be exactly the same from inside to outside, as in Fig. 4 through the entire arc. From point of tangency to point of tangency there is no difference what-

ever in the distribution of internal fiber stresses due solely to bending. The only difference in Figs. 3 and 4 is that the arc in Fig. 4 is about three times as great as the arc in Fig. 3. But the stress and strain distribution in both, due to bending, is identical, as explained in my original article.

3. Mr. Mitchell mentions "compression," which is an error that is commonly made. There is never any compression in an ordinary belt under full load. This was very clearly brought out in a recent analysis of belt behavior by a prominent manufacturer of rubber belts, which analysis appeared in most of the leading engineering journals. It is true that in a given belt section there is greater tension in the outer fibers when those fibers are on the convex side than there are on the outer or most remote fibers of the concave side. But it is a fact, nevertheless, that all of the fibers are in tension and not one fiber is in compression.

4. In view of the absence of compression there therefore is no reversal in stress. It is quite true that there is internal friction due to the continual changing in length of the inner and outer fibers. This change in length occurs because of the change in tension as the belt makes contact with the driver, driven, and wrapper pulleys. But there is no "reversal" under ordinary conditions.

5. Referring to Mr. Mitchell's Fig. 5, it is obvious, in view of the above, that the word "compression" should be removed. There is no compression. A belt would have to be a very thick one to be in compression at any point while transmitting normal load. Also, I dare say that the curves when correctly plotted will have tops and bottoms that are "flatter" than those indicated. The stresses and strains that are set up due to bending are created practically instantaneously and not as gradually as represented in Fig. 5. As stated in my paragraph No. 2, above, the stress distribution due to bending is identical from point of tangency to point of tangency. In geometry the point of tangency is clearly defined as being a "point." Therefore the tops and bottoms would be flat, and the approach lines would be almost perfectly vertical.

6. It has long been known by manufacturers of wire rope and steel cables that the length of arc embraced by a cable is of no great importance. The important thing is the radius of the bend. Thus when a cable is wound onto a 10-in. drum the stress due to bending is precisely the same as the stress on a 10-in. sheave, regardless of the smallness of the arc embraced on the sheave. In my September article I simply applied this cable knowledge to power transmission belts. The mathematics that applies to cables also applies to belts.

Newark, N. J. W. F. SCHAPHORST.

Maintenance of Plant Operating Instruments

INSTRUMENTS COVERED under this group are all of the indicating, recording and integrating types which are used in daily operation and accounting. Instruments of the operating class afford service in three ways, namely, by indicating conditions that cannot be sensed for efficient operation of equipment, by furnishing records and readings for accounting purposes, and by giving warning of abnormal conditions which call for immediate rectification in operating methods.

Considering any of the three services, the instruments themselves must be relied upon as being right otherwise results for reports have to be assumed and operating methods guessed. In order to establish this reliance on instruments it is absolutely necessary that they be maintained properly and thoroughly checked periodically. This phase of plant work is usually taken care of by those who keep the plant operating records or in some cases where instrumentation is carried out extensively, a separate maintenance department is sustained.

In order to bring about efficient instrument maintenance, coöperation must be had between the operating force and the instrument man or men. Instruments, like all other pieces of equipment especially those of the more delicate types, at times get out of adjustment through faulty operation or rough handling. In such cases they should be repaired and checked as quickly as possible. The operators of equipment usually are in the best position to spot faulty instrument operation as soon as it shows up as they know from experience what certain flows and conditions should be for certain adjustments they make on the equipment.

In order to promote and insure instrument consciousness in operation, the operators must be educated in the use of the instruments in their work and trained in the interpretation of the instrument readings. Above all they must be taught to respect the instrument's delicacy and abstain from any actions which might alter accuracy. The teaching in the use of instruments should be assumed by the instrument man. Sometimes this education must be given in small doses so as not to offend, especially in the case of new installations which call for radical changes in operating methods. It is human nature to oppose a new principle or application which is not thoroughly understood. In some extreme cases the instrument man should have a little knowledge of applied psychology to effectively bridge over the antagonistic periods.

Once coöperation is established between the operating force and instrument man it must be upheld by making prompt repairs and keeping the instruments in good working order, mechanically free, clean inside and out, and as accurate as possible. No operator will go out of his way to call attention to a faulty instrument if that instrument has been running for several years without any attention, aside from changing charts if recording, and which has leaking valves and fittings, dripping fountain pen or pens, and a general rust coated appearance. Like as not an instrument in this condition would not be considered of value by the operator in the first place so that he would not use it in his work and would not know if it were right or wrong. Instruments are to be used, otherwise they should never have been purchased and installed. The interest and use the operators make of them indicate 50 to 100 per cent of their worth.

From the foreging, one inexperienced in instrument maintenance, might receive the impression that with a half dozen instruments in a plant it would keep one man busy every day making the rounds. This is not necessary as the instruments of the present day are

of such rugged construction they will withstand a reasonable amount of hard usage. No flow meter, however can, over a long period of time, continue to give accurate results if it is neglected and allowed to get rusty and dirty. Straight temperature recorders and indicators of all types aside from pressure gages subjected to considerable vibration require less attention than flow meters. In general, the repair and inspection of instruments is not a difficult job for one having average intelligence and mechanical ability but the work must be done regularly.

The amount that instruments pay in dividends in the way of savings depends largely on how well they are maintained. Therefore, a word concerning the qualifications of a desirable instrument man may help to realize all the possible returns from instrumentation investments. As mentioned previously, he should be a type who can promote the use of instruments by the operating department. He should be a conscientious worker, not necessarily a technical man, as once the idiosyncrasies of instruments and the method of running checks is mastered the work is more or less routine. Once he is sure of his work he must have faith in the instruments and know their limitations. He should be observant and understand operation to a certain extent as it will be an aid to him in the long run. Sometimes needless checking may be eliminated by being able to find some point in operation overlooked by the operating force which caused the apparent instrument fault. Finally, an instrument man should be honest. A deliberate erroneous flow meter calibration almost affords the setting for a perfect crime in that no one ever uncovers the act. Hundreds of dollars may be gained or lost in the purchase of steam, water or gas basing the cost on readings from a flow meter having a high or low calibration. The sad part of such a crime is that the instrument man receives no monetary returns. Of course, there have never been any deliberate cases of this type but it is one of the easiest things to be careless in performing a calibration, especially if it is near quitting time and the results call for a change and another check. It is human nature to take the line of least resistance and very easy for an instrument man of the wrong caliber to say, "That's good enough." Therefore, a good instrument man must not only be honest with his employer who pays him for accurate results but honest with himself in order to obtain that end.

Kenmore, N. Y. J. C. DOWNING.

Pressure Loss in Pipe Lines

Q. How do you compute the flow of water in different pipe sizes at various pressures and is there a chart available for making these calculations graphically?

L. L. S.

Q. I am unable to calculate the pressure loss for water flowing in a pipe line and the additional loss due to valves, elbows and fittings. Is this information given in tables or charts and if so, where is it available?

G. E. M.

ANSWERING A QUESTION regarding friction flow in pipes is something like answering the question: How long does it take to go from New York to Philadelphia? So much depends upon the type of pipe, conditions of installation, the condition of the pipe, etc., that it is impossible to do more than make a reasonable guess in which experience plays a large part.

The most generally used pipe friction tables are those of Williams and Hazen, published by John Wiley & Sons and, from these tables, friction losses per 100 ft. of 15 yr. old cast-iron pipe have been plotted in Fig. 1. The friction loss of 100 g.p.m. of water flowing through 100 ft. of pipe would be 12 ft. for 2½ in. pipe, 5 ft. for 3 in. pipe and 1.22 ft. for 4 in. pipe. The size to use would depend upon the allowable friction loss and the cost of the pipe.

Another widely used table (reproduced from the National Pipe Standard published by the National Tube Co.), is shown by Fig. 2. This chart was drawn from experiments on new or clean cast-iron and wrought pipe and values are about 0.7 times those of Fig. 1, which, as stated above, is for old pipe. For very rough and badly tubercled pipe, the values from Fig. 1 should be increased 50 per cent and those from Fig. 2 doubled.

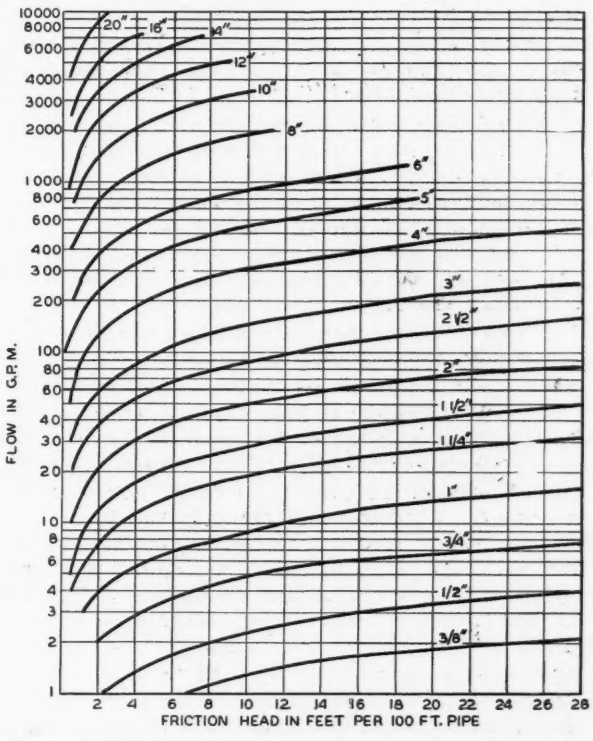


Fig. 1. Friction loss in head per 100 ft. of 15 yr. old iron pipe of different size

Figure 2 gives the quantity or discharge in cubic feet per second and the frictional loss of head per 1000 ft. of pipe for various velocities and pipe diameter. Velocities are expressed in feet per second and the diameter of the pipe in inches. With any two of the four quantities, discharge, velocity, diameter and loss of head, the other two may readily be obtained by following the line from the intersection of the lines representing the known quantities to the marginal values of the other two quantities.

If only one quantity be given, the discharge for example, the required heads and the corresponding

velocities for different diameters of pipe can be read off by following along the line for the given discharge and noting intersections. If the diameter only be fixed, the required heads for various discharges can be found by following along the line for the given diameter.

EXAMPLES

1. Given a head of 45 ft. in 3000 ft. and a pipe diameter of 5 in. The head per 1000 ft. is here 15 ft. Noting the intersection of these two lines, we find that this combination would give a velocity of about 4 ft. per second and a discharge of 0.55 cu. ft. per second.

2. Given a discharge of 2 cu. ft. per second, required the necessary head for different diameters of pipe. Following along the line for this discharge we find that a 30-in. pipe with a head of 0.023 ft. per 1000 ft.

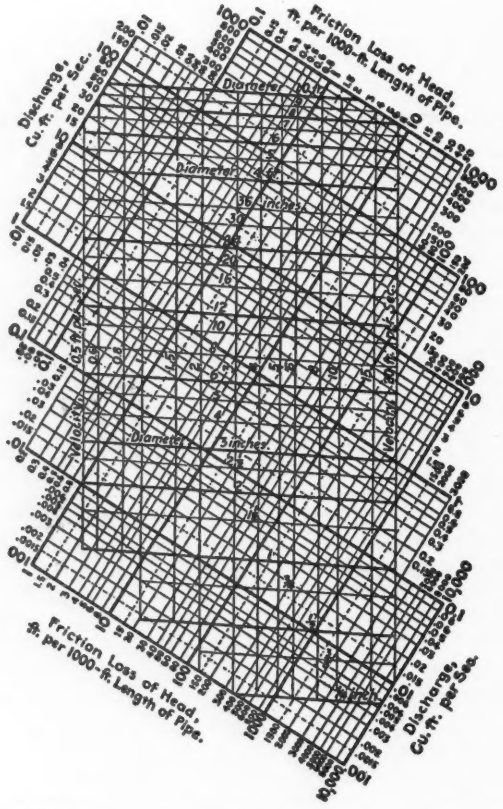

Friction Loss of Head, Ft. per 1000-Ft. Length of Pipe.
Discharge, Cu. Ft. per Sec.
Diameter 10 Inches
Diameter 15 Inches
Diameter 30 Inches
Friction Loss of Head, Ft. per 1000-Ft. Length of Pipe.
Discharge, Cu. Ft. per Sec.

Fig. 2. Friction loss per 1000 ft. of new or cleaned cast-iron or wrought iron pipe

will answer. Also pipes of diameters 20, 15 and 10 in. will give the required discharge if the heads be respectively, 0.17, 0.7, and 5.4 ft. per 1000 ft.

3. It is desired to limit the velocity in a pipe line supplying power, to 2.5 ft. per second. The quantity required is 20 cu. ft. per in. What size of pipe is necessary and what loss of head is involved? Noting the intersection of the vertical line for 2.5 ft. per second velocity with the line for 20 cu. ft. per second, we see that a 38 in. pipe, losing a head of 0.5 ft. per 1000 ft., will answer the requirements.

Increased friction due to valves, fittings, etc., are rather difficult to express in general terms although it may be closely approximated by means of the accompanying table. This table is calculated for screwed fittings but the data may be applied to flange fittings by multiplying by 0.75. A more extensive treatment of this subject was given on page 14 of the January 1, 1931, issue of Power Plant Engineering.

Equivalent Resistance of Screwed Fittings Expressed as Length of Straight Pipe in Feet

Nominal pipe size, inches	Gate Valve	Long radius ell or standard tee	Medium radius ell or tee reduced 25 per cent	Standard ell or tee reduced 50 per cent	Angle Valve	Close return bend	Tee through side outlet	Globe Valve
Resistance ratio	0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
½	0.33	0.44	0.56	0.89	1.2	1.4	1.8	2.7
¾	0.48	0.63	0.79	1.3	1.7	1.9	2.5	3.8
1	0.64	0.84	1.1	1.7	2.3	2.6	3.4	5.1
1¼	0.90	1.2	1.5	2.4	3.2	3.6	4.8	7.2
1½	1.1	1.4	1.8	2.9	3.9	4.4	5.8	8.7
2	1.5	1.9	2.5	4.0	5.4	6.0	7.9	11.9
2½	1.9	2.5	3.1	5.0	6.7	7.5	9.9	14.9
3	2.5	3.3	4.1	6.7	8.9	9.9	13.1	19.7
4	3.4	4.5	5.8	9.2	12.4	13.7	18.3	27.5
5	4.6	6.0	7.7	12.2	16.5	18.3	24.3	36.6
6	5.7	7.6	9.6	15.3	20.6	22.9	30.4	45.8
8	8.1	10.7	13.6	21.7	29.2	32.4	43.1	64.8
10	10.7	14.1	17.9	28.7	38.5	42.8	56.9	85.6
12	12.5	17.8	22.7	36.2	48.6	54.0	71.8	108.0

The friction in valves and fittings is usually expressed as equivalent to so many feet of straight pipe, thus two 90 deg. elbows and one gate valve on a 4 in. line would be equivalent to about 12.4 ft. of 4 in. pipe. 45 deg. elbows have about one-quarter of the friction loss of the 90 deg. elbow.

Steam Temperature

IN THE MAY ISSUE, on page 311, appeared a formula for determining the saturation temperature of steam. Unfortunately the constant was left out. The formula should read:

$$T = 198 + 14 \sqrt{P}$$

where T is saturation temperature in degrees F. and P the pressure in pounds per square inch gage.

Graphic Record of Blow Downs

I HAVE long felt the need for some means of checking the number of times, and the length of boiler blow downs. Many boiler room attendants and firemen are careless in this respect, especially in the smaller plants. To get around this I procured a low pressure recording steam gage and connected on to boiler blow down pipe.

This gives us a chart showing the time, and the length of time of each boiler blow down. I believe this will prove of interest to other engineers that are not sure if their orders regarding blowing down are being carried out.

WILKES-BARRE, PA. THOMAS M. STREET.

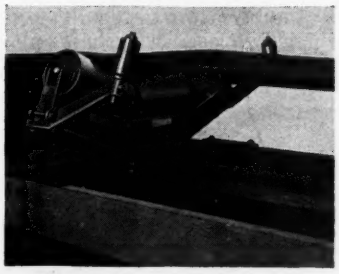
BY PROPER USE of published information much useless research can be saved. Recently a certain manufacturer believed he had a new process, wanted it developed. Examination of published literature showed that it was developed and patented in four countries nearly 25 yr. ago.—Chemical Digest.

New Equipment

Self-Alining Belt Conveyor Idler

POSITIVE SELF-ALINING anti-friction Idlers for troughed conveyor belts, is being announced by Link-Belt Co., Indianapolis, Ind., as a new and improved type of self-alining idler, which has been perfected in actual service.

The new idler functions as follows in training the belt: 1. If the belt gradually crowds sidewise, it automatically causes the idler to swivel on its anti-friction-bearing pivotal mounting, and the carrying idler rolls steer the belt back to a central position, without the belt edge contacting an actuating roll; 2. should the belt suddenly, or con-



tinuously persist in crowding sidewise enough to engage an actuating roll, the self-alining idler would be positively swiveled the amount necessary to lead and retain the belt into alinement with the adjacent stationary idlers.

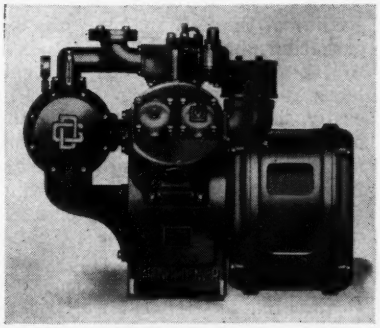
Self-alining idlers are used at intervals between the stationary carrying idlers of the conveyor, and their operation is said not to be affected either by the speed of the conveyor belt, or the load on it.

New Gardner-Denver Compressors

AVAILABLE IN sizes ranging from 113 to 194 c.f.m. displacements, a new line of 3-cylinder air compressors, known as "WBR" is announced by the Gardner-Denver Co., Quincy, Illinois.

One distinctive feature of the WBR compressor is the use of two small low pressure cylinders, instead of one large one, resulting in lower air temperature with corresponding saving in horsepower. Cylinder walls are water-cooled to provide lower wall temperature with better lubrication and longer life. In addition, the two-stage construction, with water-cooled cylinders and intercooler, assures sustained high efficiency.

A force feed pressure lubrication system is used, oil being de-



livered to the bearings by a plunger pump. Pistons and cylinder walls are lubricated by the oil spray of the crank pin.

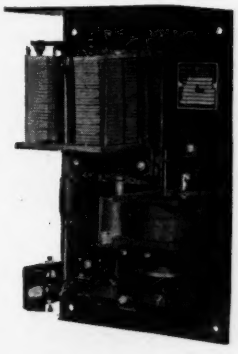
The main bearings are the Timken heavy-duty, tapered roller type. This use of roller bearings decreases the distance of the center of the main bearings to the center of the crank pin, making possible the use of the most compact and rigid crank shaft.

New Automatic Voltage Adjuster

A NEW AUTOMATIC generator-voltage adjuster, designated as Type G4, for use with small a.c. generators, synchronous motors, synchronous condensers, and d.c. generators has been announced by the General Electric Company. The new voltage adjuster has been developed to meet the need for an inexpensive regulating device where voltage-regulating requirements are not too exacting.

The Type G-4 voltage adjuster consists of a voltage-sensitive element of the movable-core solenoid type which directly operates, through levers, a wide-range, quick-acting rheostat. The rheostat is connected in the exciter (or d.c. generator) shunt field circuit, and any change in voltage is corrected by direct action of the solenoid on this rheostat. The solenoid is used for either alternating or direct current and, in either case, is excited through a fixed resistor from the generator armature potential. An air dash-pot provides anti-hunting action.

The rheostatic element consists of two vertical stacks of thin rectangular resistance plates separated by thin metal contact plates. Each resistance plate has a silver-button insert passing through one end. The parts are so arranged that when a slight pressure is applied to the top of the outer end of the stacks, the stacks tilt slightly forward, rocking the resistance plates over the metal contact plates and causing the front ends with their silver inserts to come together one at a time. The rocking action



between the resistance plates and metal spacers gives a smooth change in resistance between each pair of silver inserts. When all silver inserts are in engagement a low-resistance silver-conductor path is formed through the rheostatic element. If the pressure is released from the front end of the stacks, the rheostatic element tilts back and the circuit through the silver inserts is gradually broken and the contact resistance between plates increased so that the field current must flow through an increasing number of the resistance plates in series. In this manner, the full resistance of the unit is gradually introduced into the circuit. The action is such that there are no noticeable steps as the resistance changes, a smooth transition from maximum to minimum being obtained and permitting accurate adjustment of field current.

The adjuster is normally at rest

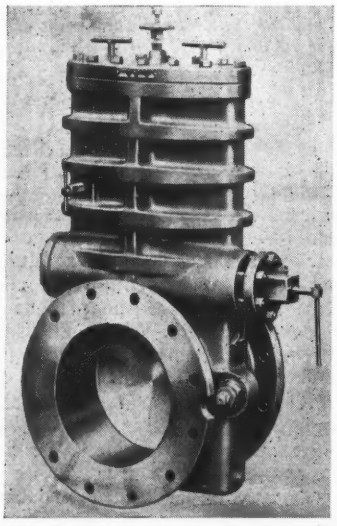
and operates only when a change in excitation is required. It acts to change excitation in the proper direction when the solenoid element senses a change in generator voltage and moves slightly, one way or the other according to whether the generator voltage increases or decreases.

Adjustment of the device to maintain a given generator voltage is accomplished by means of a sliding weight on the main operating lever between the solenoid core and the main shaft.

This device is applicable to small constant-speed a-c generators having one, two, or three phases, and with frequencies of 25 to 125 cycles. The a.c. generator must have an individual self-excited exciter suitable for shunt-field control, with the range of the exciter voltage not going below 30 per cent of rated value. The device may also be used for voltage control of small constant-speed, self-excited d.c. generators capable of shunt-field control.

Foxboro Made Agent for Orifice Fittings

ANNOUNCEMENT has been made of the appointment of The Foxboro Co., Foxboro, Mass., as sole distributors of "Commercial" Orifice Fittings, made by the Commercial Iron Works of Los Angeles, California.



Commercial Orifice Fittings eliminate the nuisance and expense of by-passes entirely, and offer a decided saving in space. The threaded elevator lift permits lowering or lifting of orifice plates regardless of line pressure, without shutting down the line and with complete safety to the operator. Additional features such as the accurate centering of orifice plates and elimination of set screws in pressure areas, also are important.

Electronics and Electron Tubes

THREE PUBLICATIONS on theoretical and experimental electronics and electron-tube applications, originally published for educational institutions have now been made available to the public, at a nominal charge, by the General Electric Company, Schenectady, N. Y.

"Electronics and Electron Tubes" was written by E. D. McArthur of the G-E vacuum tube engineering department in response to requests from schools and colleges for a publication giving, in easily understood language, the fundamentals underlying the vacuum tube, and including simple experiments to illustrate these fundamentals. References are included which enable the reader to delve more extensively into many subjects treated in the 48-page booklet. Designated by General Electric as publication GET-568-A, it is priced at 25 cents.

The other two publications, GET-566 and GET-620, deal with laboratory experiments on electron-tube theory and on electron-tube applications, respectively. The former is intended as an experimental supplement to McArthur's "Electronics and Electron Tubes", while the latter is a laboratory manual covering a number of fundamental electron-tube applications. The two booklets are obtainable as a combination priced at 25 cents. Address: Educational Section, General Electric Company, Schenectady, N. Y.

Roto Junior Tube Cleaner

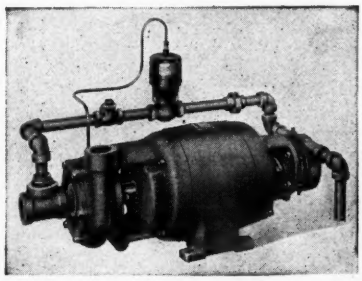
ROTO COMPANY, Newark, N. J., has added to its products a new air driven cleaner, called the Roto Junior which is designed for use in small diameter tubes and is entirely self-contained. Its outstanding features are its simplicity, having only two moving parts, and its ease of handling which permits a number of cleaners to be operated simultaneously in the same tubular apparatus. The Roto Junior will clean straight tubes as small at $\frac{5}{8}$ in. O. D. and curved tubes with short radius bends as small as $\frac{7}{8}$ in. O. D.

The Roto Junior is built on the Rotocentric principle which has been an exclusive feature of the company's larger cleaners since 1910. Very little headroom is required, and either horizontal or vertical tubes can be cleaned. The entire cleaner can be taken into the condenser header. It operates at pressures of from 30 to 75 lbs. with an air consumption of from 12 to 20 cu. ft. of free air per minute.

A circular describing the new Roto Junior may be secured by writing to the Roto Company, 140 Sussex Avenue, Newark, N. J.

Automatic Self-Priming Pump

A PUMP that will prime itself when necessary has been developed by the Worthington Pump & Mach. Corp., Harrison, N. J., by the use of the Worthington-built Hytor, which is a positive primer, placed on the same shaft with the motor



and pump. The only requirement is a reasonably tight suction line. When the pump is primed, a pressure-operated cutout automatically unloads the Hytor. There is no recirculation of water, there are no floats nor valves, The pump is available for single or polyphase 50 or 60 cycle alternating current as well as for direct current operation.

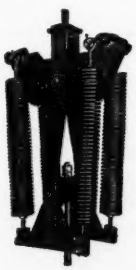
Hard Surfacing Electrode

A NEW HARD surfacing electrode which is designed for building up straight carbon steel, low alloy or high manganese steel surfaces to resist abrasion is announced by The Lincoln Electric Co., Cleveland, Ohio, known as Abrasoweld, and for such applications as restoring teeth, lips and bottoms of power shovels; lugs and

treads of tractors; housings and impellers of centrifugal sand pumps; rock crushing equipment; agricultural machinery; gear and pinion teeth. Abrasoweld deposit develops its maximum hardness only at the surface, where it is cold worked by impact, leaving a strong tough core for resisting shock. The deposit is more resistant to corrosion than high manganese steel, yet can be forged hot without materially altering its physical properties.

Grinnell Genspring Pipe Hangers

ONE OF THE RECENTLY developed products of the Grinnell Company, Providence, R. I., is the Grinnell Genspring constant-support hanger which floats pipe lines with complete freedom for movement in any

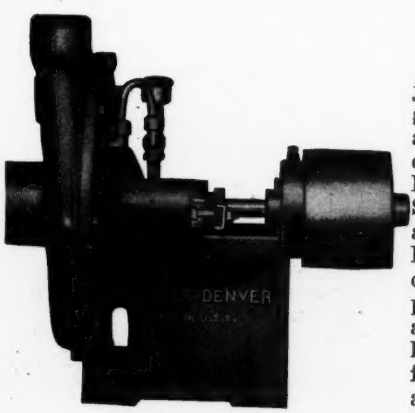


direction while affording constant and adequate support throughout the entire range of vertical and horizontal movement.

These hangers are made in three frame sizes: light, medium and heavy duty.

Side-Suction Centrifugal Pumps

GARDNER-DENVER Co., Quincy, Ill., is introducing a new line of centrifugal side-suction pumps designed especially for general service conditions and for low investment and installation costs. These Type B and C pumps handle capacities up to 450 g.p.m. at heads up to 100 ft.



A heavy-duty ball bearing at the pulley end of the shaft takes the thrust load and the belt pull, and, at the impeller end of the shaft, where the load of the bearing is light, an ample-size sleeve bearing is used. By the use of shims the thrust bearing is made adjustable to take up wear between the impeller and the casing. Frames are one-piece castings constructed of close grained cast iron machined to fit the bearings and the volute and are amply proportioned to resist belt pull and pressure in the pump.

Circuit Analyzers

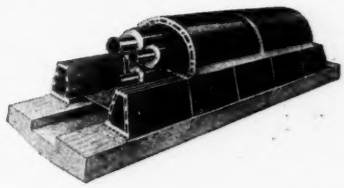
THE NORTON Electrical Instrument Co., Manchester, Conn., has recently developed a line of "Circuit Analyzers" in compact units of two, three or four instruments. These analyzers take the place of separate instruments when testing electrical equipment or in general electrical maintenance work. Instruments of any type may be incorporated in these units. For example, a two instrument set may consist of an ammeter and a wattmeter, or a kv-a. meter and a wattmeter or if three instruments are desired, a voltmeter also may be included. The instruments are conveniently mounted in a single case fitted with a comfortable handle for carrying. They are supplied for plug connections up to 20 amperes inclusive unless otherwise specified. Higher ranges have binding posts.

Joint Cement

FOR MAKING up permanent joints in pipes, tanks, pumps, engines, turbines where two metals are to be joined in a permanent connection, a new product of the Key Boiler Equipment Co., East St. Louis, Ill., has been developed and is marketed under the name Key Formatite Joint Connect. This cement is insoluble in water and petroleum products making it suitable for joints exposed to these liquids. Alcohol is the best solvent for this cement and is used when a thinner mixture is required.

Steam Conduit System

UNDERGROUND STEAM CONDUIT SYSTEM named Therm-O-Tile, has recently been placed on the market by H. W. Porter & Co., Inc., Newark, N. J. First a concrete base 4 in. thick is poured directly into the trench bottom. On this immovable base the conduit and piping rest independently of each other. The concrete base, (1) keeps the trench free from water during installation, (2) keeps the pipe space absolutely dry while the lines are in service, (3) permanently supports the conduit and the pipe lines, and (4) serves as a sidewalk on which the mechanics can do their work more conveniently and more quickly.



All pipe lines are supported directly from the concrete base, independently of the tile envelope and are held by special cast iron adjustable supports. This conduit can be made perfectly leakproof and submerged under water where necessary. In its standard form, Therm-O-Tile is waterproof under all normal soil conditions, no special waterproofing being required unless the water level in the soil is above the base slab.

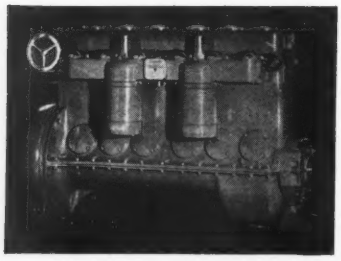
New Diesel Engine

DIESEL ENGINES of new design have just been placed on the market by the Murphy Diesel Co., Ltd., Milwaukee, Wis. The first unit type MD6 is a 3¾ by 6½ in. six cylinder unit, with an economical horsepower range from 100 to 150 hp. This will be followed by smaller engines.

One of the design features is a fuel pump and nozzle combined in a single injector unit which is placed in the center of the cylinder head and surrounded by four valves. This injector unit is actuated directly by two camshafts, one on each side of it, thus forming a balanced drive. Injectors are spring loaded and ride on the cams. Oil is delivered to injectors under 10 lb. pressure, in excess of maximum demands, surplus oil being returned to the fuel tank. Actual injector pressure of the fuel into the combustion chamber ranges from 2000 lb. at low to 4500 lb. at maxi-

mum speed, this pressure being confined to less than one inch of travel, concentrated in the very tip of the injector.

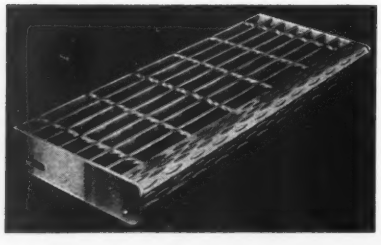
Other features of the new MD Diesel are: Gasoline starting; oil-tight and dust-tight construction;



water pump and oil pumps mounted directly on the crankshaft; temperature control that holds lube oil and cooling water within 20 deg. F. of each other; oil bath air cleaners built into the inlet manifold; centrifugal, flyball type governor controlling an hydraulic servo motor.

Blaw-Knox Stair Tread

THE NEW Electroforged Stair Tread now manufactured by Blaw-Knox Co., Pittsburgh, Pa., uses a nosing made from rolled diamond checkered plate. This nosing defines the edge of each tread because of the very definite contrast between the checkered plate and the grating construction. These stair treads are made from Blaw-Knox Electroforged Steel Grating, which developes the full strength of the metal used. The intersections of



the bars are electroforged into one piece under pressure. This is done without cutting, slotting or punching the bars or the removal of metal in any way. It eliminates all loose parts and any tendency to rattle.

Slipping is prevented by the twisted cross-bar feature which affords a grip for shoe soles even under wet, greasy or icy conditions. Cleanliness is insured by the design and painting or galvanizing will eliminate corrosion.

Splice for Rubber Belt

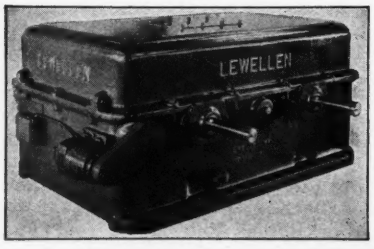
ANNOUNCEMENT of a patented vulcanized splice for the Compass Cord transmission belt was made recently by The Goodyear Tire & Rubber Co., Akron, Ohio. By means of this vulcanizing method, Goodyear Compass Cord belts now can be made endless on the drive. This development enables belt users to obtain this belting in roll-lot, non-endless lengths for use on belt drives where it formerly was necessary to dismantle the pulleys to install an endless belt.

The ends of the Compass belt are joined together by dovetailing the load-carrying core of cords at the splice end by vulcanizing the spliced portion of the belt with a portable vulcanizer developed for this purpose. The Compass Cord belt is so constructed that the load is carried entirely by a layer of cords, laid side by side, embedded in rubber, and sheathed in a protecting fabric envelope.

Lewellen Produces Large Transmission

NOW IN production as one of the standard sizes built by Lewellen Manufacturing Co., Columbus, Ind., the enclosed variable speed transmission unit illustrated here is reported to be the largest of its kind ever built.

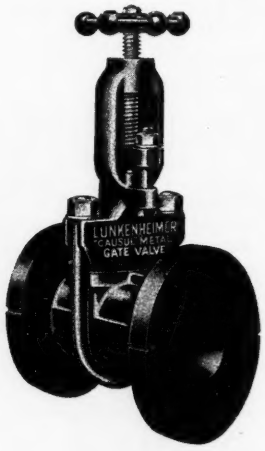
This is a complete ball bearing transmission. All of the interior parts are lubricated from one end of each shaft which may be accom-



plished while the transmission is running. Electrical remote control is used to operate the variable speed mechanism. Dimensions of the transmission are: overall length, 24 in.; width, 52 in.; height, 38½ in.; weight, 5620 lb., and capacity, 40 hp.

Lunkenheimer "Causul" Metal Valves

CORROSION RESISTANCE is the distinctive feature of the new "Causul" metal valves, recently placed on the market by the Lunkenheimer Co., Cincinnati, O. Sulphuric acid, alkalis and many other corrosive fluids have been success-

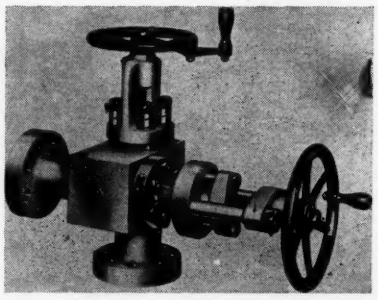


fully and economically handled in the manufacture of sugar, paper, textiles and rayon, rubber, caustics, fertilizer, in oil refineries, in coke and by-product and water softening processes.

"Causul" metal is an austenitic ferrous alloy, particularly resistant to corrosion. In addition to gate valves in screwed and flanged patterns, the line includes a "Causul" metal indicator cock with diamond shape port for acid sludge and oil burner service.

New Yarway High Pressure Blowoff Valve

DESIGNED for pressures of 600 and 1500 lb., this new type of blowoff valve, developed by Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., is distinctive in that the valve body is a single forged block serving both sealing and blowing valves.



For the sealing valve, the Yarway seatless design is used with every refinement which years of metallurgical research and engineering experience have been able to contribute toward its improvement. The blowing valve is a new hard seat Yarway valve, utilizing special alloys and unique construction features.

Serving as the common body for both valves, the one-piece forged steel billet has flanged forged steel inlet and outlet nozzles screwed and welded into it. This unit does away with flanges, bolts and gaskets normally used between tandem valves.

Pumps for Volatile Liquids

ROOTS-CONNERSVILLE BLOWER CORP., Connersville, Ind., has recently introduced a line of volatile liquid pumps which are primarily designed for use in bulk station service, although they are adaptable to several other applications in kindred fields.

These units utilize the standard type "T" turbine pump but are equipped with a priming chamber, including integral by-pass and relief valve, which, according to the company, enables these pumps to handle gasoline satisfactorily even in the hottest summer weather. An inherent high vacuum readily evacuates long pipe runs, thus facilitating the self-priming of these pumps. Sizes range from 20 to 350 g.p.m.

Smoke Prevention Ass'n Convention

ON JUNE 4 to 7 the Smoke Prevention Association will hold its twenty-ninth annual convention in the Hotel Statler, St. Louis, Mo. Among the subjects of interest to power engineers which will be discussed are: The Smoke Abatement Problem from the Civic Viewpoint; Measuring Smoke Densities with Photo Electric Cell Indicators and Recorders; Modernization of Boiler Furnaces for Increased Combustion Efficiency and Smoke Abatement; Elimination of Solids from Chimney Discharge and Method of Testing and Measuring; Commercial Aspects and Development of Mechanical Solid Fuel Firing; and Characteristics of Underfeed Stokers.

Frank E. Trumble, Chief Smoke Inspector, Buffalo, N. Y., is president of the association and Frank A. Chambers, Deputy Smoke Inspector, Chicago, Ill., is the national secretary.

First Floating Power Show

AMONG the principal exhibits of the Great Lakes Power Show and Mechanical Exposition to be held this June will be the demonstrating model of the Modern Group Drive, the traveling laboratory of the Power Transmission Council. One entire section of the main exhibit hall surrounding the Power Transmission Council exhibit will be set aside for displays by manufacturers of power transmission equipment.

The entire Great Lakes Show will include over 200 displays of industrial products and will constitute the first power or mechanical exposition ever to be staged on shipboard and presented in three cities. Exhibitors who are arranging for displays include: national manufactuers of industrial insulation, ceramic products, packing, pumps, boilers, handling machinery, gages, meters; indicating, recording and control instruments, fire extinguishers and other plant accessories, refractory and abrasive materials, motors, factory maintenance supplies, heavy machinery, valves, steam specialties, processing equipment and other industrial products. The Seeandbee of The Cleveland & Buffalo Transit Co. will house this traveling power show.

In addition to showing for one 14-hr. day in each of three industrial centers, the Seeandbee will carry 500 passengers asociated with the exposition as it moves from port to port. The greatest portion of this passenger list will be comprised of salesmen in charge of exhibits and the show management and advisory heads. The dates of the show are: Buffalo, June 25; Cleveland, June 26; Detroit, June 27.

Stewart A. Jellett

ON APRIL 5, 1935, Stewart A. Jellett, Charter Member, Presidential Member and Honorary Member of the American Society of Heating and Ventilating Engineers, died at his home in Philadelphia at the age of 73, after a lingering illness.

Stewart A. Jellett was a pioneer in heating and ventilating engineering and was one of the few privileged to live long enough to realize and enjoy the great developments which occurred in this field during the last half century. He was an active member of the Heating, Piping and Air Conditioning Contractors National Association and in 1900 served as a Director, became President in 1901 and in 1902 and 1903 was Chairman of the Board of Directors. To the American Society of Heating and Ventilating Engineers, Mr. Jellett rendered distinguished service as President in 1895, as Secretary in 1898, as Chairman of the Board of Managers in 1899, and as a member of the Board of Managers from 1895 to 1899.

He was a Charter Member of the Society and was one of a small group of men who met in 1894, to organize the American Society of Heating and Ventilating Engineers. At the first annual meeting held in New York Mr. Jellett was elected President of the Society.

Lawrence Machine & Pump Co. Changes Ownership

VICTOR J. MILL of Baldwinsville, N. Y., has purchased the Lawrence Machine & Pump Co. of Lawrence, Mass., and will continue to operate it under the name of the Lawrence Machine & Pump Corp. This company, which was established in 1882, made the first centrifugal pump in the United States.

Mr. Mill, who has been prominent in the industry for nearly 20 yr., plans to continue the "Lawrence" line of pumps with many new improvements in design. The line will include centrifugal pumps for a broad and varied field, notably single and multi-stage water pumps, stock pumps, sewerage and sludge pumps, slurry pumps, chemical pumps and sand and dredging pumps.

In addition the plant will build hydraulic dredges and special machinery, a field in which Mr. Mill has had a wide experience. The plant is particularly well equipped for this latter type of work.

News From the Field

OVER 200 STUDENTS of Midwest Engineering Colleges gathered at the Allerton Hotel in Chicago on April 29th and 30th for the Third Midwest Student Conference of the A.S.M.E. Fifteen well prepared papers were presented by representatives of the fifteen engineering schools participating, and the following awards were made: First Prize, Edward J. Wellauer, Marquette University, for his paper on A Mathematical Determination of the Contact Length of Helical and Herringbone Gearing; Second Prize, Einar W. Jensen, University of Iowa, for his paper Stresses in an Automobile Engine Crankshaft; Third Prize, Janus DeHamer, Michigan College of Mining and Technology for his paper, The Development of a Test for Set in Split Bamboo Fishing Rods; Fourth Prize, Walter Schlagel, Iowa State College, for his paper, Employment Conditions Among Recent Engineering Graduates.

The opening session, presided over by Charles Mackie, of Lewis Institute, was addressed by L. D. Gayton, representing the mayor of Chicago, Alex D. Bailey, representing the president of the A.S.M.E., and R. D. Brizzolara, Chicago, section chairman. The first and second technical sessions were presided over by Walter Schlagel of Iowa State College and Janus DeHamer of Michigan College of Mining and Technology, respectively. John E. Pearson of Purdue University, was toastmaster at the banquet and entertainment held Monday evening. W. L. Abbott and Alex D. Bailey of Commonwealth Edison Co. gave short talks preceding the main address of the evening delivered by Wm. A. Hanley of Eli-Lilly and Co., on Government and Engineering in the Future.

Prizes were awarded at the luncheon meeting on Tuesday presided over by John F. Schmidt of University of Michigan. At this meeting L. W. Wallace, of the Association of American Railroads, addressed the group on "Engineering Technique." At the breakfast for the honorary chairmen and faculty members, Prof. J. S. Kozacka of Lewis Institute, presided. Plant inspection trips arranged by Joseph J. DeBoo of Armour Institute, included Illinois Steel Co., International Harvester Co., McClintic-Marshall Co., and Crane Co.

ON JUNE 11-14 the National District Heating Assn. will hold its 26th Annual Convention at the Bellevue-Stratford Hotel, Philadelphia. In addition to a complete program of papers and committee reports, an extensive entertainment and inspection trip program has been prepared. Election of officers will be held at the last session of the convention on Friday.

AT THE BOOK-CADILLAC HOTEL, Detroit, The American Society for Testing Materials will hold its 38th Annual Meeting, June 24-28. The opening session will be addressed among others, by C. F. Hirshfeld of the Detroit Edison Co., speaking on "The Relation of Specifications to the Engineering Profession." In addition to a large number of papers and committee reports, there will be the Tenth Edgar Marburg Lecture, delivered this year by L. B. Tuckerman, of the Bureau of Standards on the subject of "Air Craft: Materials and Testing."

JOSEPH W. ROYER, Works Manager of The Medart Co., was recently elected Vice President in full charge of manufacturing. His connection with the company dates back to 1915.

A. J. O'LEARY has been appointed Assistant to General Manager of Sales of Lukens Steel Co., Coatesville, Pa. Prior to joining the Lukens organization in 1916, he was with the Pennsylvania Railroad and Alan Wood Steel Co. He spent 5 yr. in the mills and mill service departments at Lukens before he was transferred to the sales department, where he served since 1931 until his recent appointment.

AN AGREEMENT, applying only to the sale of industrial electro-chemical instruments and certain types of flow-meters, has been consummated between Leeds & Northrup Co. of the United States and George Kent, Ltd., of Great Britain. Under this agreement, Kent will not offer its industrial electro-chemical instruments or its flowmeters for sale in the United States or Canada unless through Leeds & Northrup, while Leeds & Northrup will not offer its similar instruments for sale in the British Empire (except Canada) unless through Kent. Neither the sale, in the States by Builder's Iron Foundry, of Kent venturi and shunt type rotary meters, nor the sale anywhere by either company or its agents, of products other than those specifically mentioned is in any way affected.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., and the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a joint office at 303—the 101 Marietta Street Building, Atlanta, Georgia, to serve the Southeast. Wesley R. Moore, for a number of years District Manager of Brown Instrument Co., is Manager in charge, with Leon L. Kuempel, Sales Engineer, Charles A. Kitzinger, Service Engineer, and J. A. Crawley, Office Manager.

FRICK CO., INC., Waynesboro, Pa., has lately appointed the following distributors in the territories represented by their addresses: Wolf Engineering & Sales Co., Harrisburg, Pa.; George W. Mack Co., Atlantic City, N. J.; Nicholas Panzarello, Wilkes Barre, Pa.; Kline Brothers, Wilkes Barre, Pa.; R. P. Johnson, Wytheville, Va.; Dillon Supply Co., Raleigh, N. C.; Smith & Berry, Birmingham, Ala.; Hendrickson Machine Co., Cleveland, Ohio; Des Moines Steel Co., Des Moines, Iowa; Bell & Coerver, Phoenix, Arizona; Wells & Wade, Inc., Wenatchee, Wash.; Trenco Limited, Kelowna, B.C., Canada.

HENRY VOGT MACHINE CO., Louisville, Ky., announces that Wm. R. Van Nortwick, for many years identified with boiler and combustion work in the metropolitan territory, has been appointed representative of the company and will be located in the New York office at 80 Broad St. The company also announces that Robert F. Koch, formerly with the Foster Wheeler Corp., is now representing the company in the Cleveland territory with headquarters in the Rockefeller Building, Cleveland, Ohio.

THE CHICAGO OFFICES of The De Laval Separator Co., from which all of the De Laval Middle Western business is handled, have been moved to 427 Randolph St., Chicago. At this location De Laval is centrally and conveniently located, and among other new features of their modern offices is a display room where samples of various De Laval equipment is exhibited.

UNDER THE CORPORATE name of Behrer-Nason Co., Inc., a merger of interests has been effected between the Nason Mfg. Co., and Behrer & Co., which will take place on June 1. The company will continue offices in New York City at 81 Beekman St.; Long Island City, 50 Davis St.; Mineola, N. Y., White Plains, N. Y., and New Brunswick, N. J. Raymond Seabrook, President; John Harmon, Vice-President and Thomas F. Larkin, Secretary-Treasurer, will retire from active participation in the business and the Nason Mfg. Co., will operate merely as a holding corporation. Behrer-Nason Co., Inc., will include the former officers and personnel of Behrer & Co., to which will be added many of the Nason Mfg. Co. staff, including Charles F. Blake, John A. Van Wyck, David E. Allen, Albert Davis, W. W. Wright and William F. Dailey. The Nason Mfg. Co., was founded in 1841 and Behrer & Co. in 1897, and both companies have earned an enviable business reputation.

THE U.S. BUREAU OF RECLAMATION has awarded a contract to Bailey Meter Company covering turbine flow meters for the initial installation of four 115,000 hp. hydraulic turbines at Boulder Power Plant, Boulder Canyon Project. These fluid meters which will be installed on the World's largest hydraulic turbines will measure water supplied through 13 ft. diameter penstocks under an average net head of about 530 ft.

The meters will indicate and record water flow in terms of cubic feet per second and will continuously integrate in millions of cubic feet. Each meter will be designed for a maximum differential pressure of approximately 120 in. of water and will be connected to Winter-Kennedy pressure connections in the turbine scroll casing.

ARTHUR C. HAYS, 1415 Carondelet Building, New Orleans, Louisiana, has been appointed sales representative for The Edward Valve & Manufacturing Co., Inc., East Chicago, Indiana, in the New Orleans district.

JOSEPH C. JONES has associated himself with Sanderson & Porter, engineers, at 52 William St., New York. Mr. Jones was with Ford, Bacon & Davis, Inc., until March 1, and formerly with Thomas E. Murray, Inc., in both cases engaged in furthering their activities in connection with industrial and public utilities works, and will be similarly engaged with Sanderson & Porter.

T. A. CANTY, Baltimore, Md., distributor of arc welding equipment and supplies manufactured by The Lincoln Electric Co., Cleveland, Ohio, has moved from 116 East Centre Street to much larger quarters at 1023 Cathedral Street.

L. C. FROHRIEB AND VAN A. REED, JR. of The Federal Engineering Co., Pittsburgh, Pa., for the past 20 yr. sales representatives for the Nordberg Manufacturing Co., Milwaukee, Wis., announce their appointment in Western Pennsylvania, Eastern Ohio and Northern West Virginia, as sales representatives for the Steel Boiler Division of the National Radiator Corp.

For the Engineer's Library

AUTOMATIC SWITCH CO., 154 Grand St., New York City, has recently issued a catalog entitled Solenoid Valves for Automatic and Remote Control. These valves are applicable to steam, gas, liquids and air, and the catalog is quite complete in its description of the various types of valves for operation and electrical connections.

C. J. TAGLIABUE MFG. CO., Brooklyn, N. Y., has issued Bulletin No. 1101 describing their photoelectrically balanced recorders, and pyrometers.

VERTICAL ANGLE COMPRESSORS with piston displacements of from 4.08 to 70 cu. ft. per min. are described in a six page leaflet L 620-B-8 issued by the Worthington Pump & Machinery Corp., Harrison, N. J.

SMALL AIR COMPRESSOR UNITS with full automatic start and stop control and thermal overload protection as built by Worthington Pump and Machinery Corporation, Harrison, N. J., are described in a 4 p. bulletin L-621-B7A. The displacement of these units ranges from 1.34 to 10 cu. ft. per min.

COMMERCIAL STANDARD CS12-35 covering Fuel Oils has just been issued as a Third Edition and became effective for new production on Feb. 15 of this year. Copies of these standards may be obtained from the Supt. of Documents, Washington, D. C., for 5c.

HORIZONTAL TWO CYCLE oil field type engines are described in an 8-page bulletin issued by the Worthington Pump & Machinery Corp., Harrison, N. J. These engines with a power range of 40 to 75 hp. and from 180 to 350 r.p.m., are convertible from gas to fuel oil.

THE FUEL ENGINEERING CO. of New York has just published a booklet entitled "The Stream of Experience," which is a revised edition of the book first published in 1933. It is an institutional piece of literature, giving the background of experience of the company and the principal specialists of the organization.

THE EAGLE-PICHER LEAD CO. has recently issued a comprehensive bulletin on effective heat insulation dealing with fill materials, flat materials, plastic materials, pipe insulation, home and building insulation. The bulletin is full of useful tables, charts and halftone illustrations, all of which are designed to aid the engineer in the choice of his insulation.

ARMSTRONG MACHINE WORKS, Three Rivers, Mich., has just issued a comprehensive catalog entitled The Armstrong Steam Trap, Catalog A, Third Edition, which is in fact a text on the use of Armstrong traps, giving illustrations of the various types and designs together with tables of capacities, prices and curves for selecting the proper size trap for the conditions of service.

LIEB-JACKSON, INC., Columbus, Ohio, is distributing recently published literature on the Protect-O-Lytic System which has been developed to eliminate corrosion and pitting in piping systems or other vessels containing water. This system works on the electrolytic principle.

WHAT THE OWNER, the architect, the engineer and the contractor need to know about electrical thermometers for air conditioning systems is told in a concise, orderly way in a well illustrated, 24-page bulletin No. 4001, Efficient Regulation of an Air-Conditioning System, just issued by the Leeds & Northrup Co., Philadelphia, Pa.

WOOD PRESERVATION is comprhensively treated and the use of No-D-K, a creosote preservation, is set forth in a pamphlet issued by Tennessee Eastman Corp., Kingsport, Tenn. The discussion covers, destruction of cross-arms, poles and structural lumber by dry rot and termites and illustrates various methods of application of the preservative. Copies are available free on request.

"AEROVOX CONDENSERS FOR INDUSTRIAL USES" is the title of an interesting 24-page catalog recently issued by the Aerovox Corporation of Brooklyn, N. Y. This booklet contains interesting information on the construction and characteristics of various types of condensers, both electrolytic and paper dielectric types and discusses their application, particularly with respect to motor starting.

LINK-BELT CO., 2410 W. 18th St., Chicago, has recently issued two folders designated as Nos. 1458 and 1459, both containing data on underfeed screw type stokers in sizes up to 300 b.hp.

LEUPOLD, VOLPEL & CO., Portland, Ore., recently published a third edition of its Data Book describing the instruments built by this company for stream flow measurement and including tabulated information for hydraulic engineers.

A NEW BULLETIN dealing with the design of modern industrial piping systems has just been issued by Tube-Turns, Inc., 425 Fifth St., Louisville, Ky. Included in the bulletin are a number of charts by means of which correct pipe sizes and pressure drop can be easily figured. The charts are drawn up in such a manner that the most economical pipe size and amount of pressure drop can be read directly from the charts. The data covers the flow of fuel oils, lubricating oils, cotton seed oil, water, brine, gasoline and ammonia at temperatures ranging from —20 to 400 deg. F.; and steam, air, oxygen, nitrogen, hydrogen and ammonia at temperatures from —100 F. to 1200 F.

MODERN RADIATION is the title of a catalog issued by the Shaw-Perkins Manufacturing Co., Oliver Bldg., Pittsburgh, Pa., which describes the company's convector-radiators for residential, commercial, industrial and marine heating systems.

NIAGARA COMBUSTION CORP., Niagara Falls, N. Y., has just issued a bulletin on the Cumberland Electrolytic System for the prevention of corrosion and elimination of scale in boilers, condensers, economizers and other vessels containing water. The bulletin gives data on causes of corrosion, prevention of corrosion and scale, and a general description of the Cumberland System which consists of immersing in the water, within the boilers or other units to be protected, insulated plates called anodes connected to the positive pole of the source of direct current electricity, the strength of the current being varied to suit the total amount of surface to be protected.

IN AN attractive 15-p. booklet Murex all-mineral coated welding electrodes are described by the Metal & Thermit Corp., 120 Broadway, New York, N. Y. Patented spiral winding of asbestos anchors the extruded coating to the core wire, assures uniform thickness of the coating and prevents wandering of the arc when welding.

ALLIS-CHALMERS MANUFACTURING CO. has recently issued several new publications dealing with electric motors and generators. Leaflet 2100 presents the details of their wound rotor induction motors and Leaflet No. 2183 deals with their Type E direct current motors and generators. Another publication known as Bulletin 1172 is devoted to a description of the new Allis-Chalmers quick clean motors.

JENKINS BROS., 80 White St., New York City, has recently issued three folders, each dealing with a specific type and design of valve. Form No. 159 takes up regrinding iron body gate valves; Form 160 twin-bolt gate valves, and Form 162 bronze gate valves.

PARKER APPLIANCE CO., Cleveland, O., has just issued its bulletin No. 39 on Parker Production tube benders. The bulletin gives instructions as to the use of these tools and includes a price list.

TWO STAGE CENTRIFUGAL volute pumps, Type U, are described in Bulletin W-318-B6A issued by the Worthington Pump & Machinery Corp., Harrison, N. J.

RATHBUN CO., INC., 611 So. Ochoa St., El Paso, Texas, has recently issued its bulletin B 20 describing the Rathbun system of boiler feedwater treatment for high and low pressure boilers, treatment being controlled both chemically and mechanically.

COMBUSTION ENGINEERING CO., Inc., 200 Madison Ave., New York, in an eight-page catalog recently published gives general specifications for a line of horizontal return tubular boilers. These boilers were formerly known as Casey-Hedges and Walsh-Weidner. Both riveted and fusion welded construction for the shells are shown and various details of the boilers, grates and breechings, are included as well as general information on settings.

THE FOXBORO CO., Foxboro, Mass., announces the recent publication of a 48-page bulletin entitled "Meters for Steam—Liquids—Gas." This comprehensive bulletin covers the complete line of Foxboro meters for industrial uses. Of particular interest is the description of the new Universal Flow Meter which was developed to measure steam, water, air, oil, gas, and all kinds of chemical solutions under any industrial conditions.

USERS OF AUTOMATIC CONTROL valves will be interested in Catalog No. 25 recently issued by Golden-Anderson Valve Specialty Co., Fulton Bldg., Pittsburgh, Pa. This is an attractive 64-page booklet, size 8 by 11 in., describing the Golden-Anderson line of automatic control valves, especially designed for steam and water service. The catalog is profusely illustrated with sectional views and drawings of the valves and includes full data on applications, pressures and temperatures and sizes.

Power Plant Construction News

Ark., Fort Smith—Ozark Distillers, Inc., A. S. Bullock, Merchants' National Bank Building, secretary, organized a few months ago, plans installation of electric power equipment in new distillery and winery, for which site has just been purchased. Proposed to begin work soon. Entire project will cost about $100,000.

D. C., Washington—Board of District Commissioners, District Building, plans early call for bids for new sludge dewatering plant and power station at new sewage treatment plant at Blue Plains. Two such units will be built, one estimated to cost $400,000 and the other $318,000, with equipment. Work is being started on complete project, and bids for other features of plant also will be asked soon. Metcalf & Eddy, Statler Building, Boston, Mass., are consulting engineers.

Fla., De Land—City Council plans new municipal electric light and power plant. Fund of $525,000 has been secured through PWA for new station, waterworks construction and municipal incinerator plant. Proposed to ask bids in near future.

Fla., Fort Myers—Lee County Packing Co., plans installation of electric power equipment in connection with proposed rebuilding of citrus fruit packing plant, recently destroyed by fire. Entire project is reported to cost over $60,000. John M. Dean is president.

Idaho, Twin Falls—Idaho Power Co., Boise, Idaho, is considering plans for new hydroelectric generating plant on Snake River, where site about 8 miles from Twin Falls has been selected. Station will be of semi-automatic type, equipped for initial capacity of about 8400 kw. Cost over $1,000,000 with transmission line for connection with present system. Company engineering department is in charge.

Ill., Chicago—Armour & Co., Union Stock Yards, meat packer, plans installation of electric power equipment in new multi-story beef-packing plant at Union Stock Yards. Cost over $500,000. Bids have been asked on general contract. Company engineering department is in charge.

Iowa, Iowa City — City Council has engaged Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., consulting engineer, to prepare plans for proposed new municipal electric light and power plant. Bids will be asked in near future. Cost about $917,000. Financing in that amount is being arranged.

Ky., Fisherville — Coffey Distilling Co., Fisherville, plans one-story power house at proposed new distillery. Electric power equipment will be installed in distilling units. Entire project is reported to cost close to $100,000. Walter C. Wagner, Breslin Building, Louisville, Ky., is architect.

La., Monroe—Bancroft Bag Co., manufacturer of paper bags, etc., plans installation of electric power equipment in new one-story addition to paper converting plant. Cost about $80,000. Herbert Dickard, Monroe, is consulting engineer.

La., New Orleans—New Orleans Alcohol Distilling Corporation, Maritime Building, affiliated with the Louisiana Dairy Products Corporation, same address, plans installation of electric power equipment in new plant on waterfront, where group of four buildings will be remodeled and improved. Cost over $80,000. William O. Hudson is president.

Mass., Gardner—Florence Stove Co., School Street, manufacturer of oil and gas stoves, plans installation of power equipment in two new additions to plant, for which superstructure will begin soon. Cost about $70,000. Frank D. Chase, Inc., 307 North Michigan Avenue, Chicago, Ill., is architect and engineer. .

Mich., Grand Rapids — Michigan Brewing Co., operating the former local brewing plant of Grand Rapids Brewery, plans intsallation of electric power equipment in connection with an expansion and improvement program at plant. Entire project will cost about $300,000.

Mich., Kalamazoo—Kalamazoo Label Co., manufacturer of paper labels, etc., plans installation of electric power equipment in new one-story addition to paper converting plant. Cost close to $40,000. M. J. Billingham, Kalamazoo, is architect..

Mich., Salzburg—Strange & Fortney Oil Co., care of Delbert Fortney, Mount Pleasant, Mich., head, plans installation of power equipment in proposed new oil refinery on 12-acre tract of land recently acquired at Salzburg, near Bay City. A power house will be built. Entire project will cost over $250,000.

Minn., Duluth—Diamond Calk Horseshoe Co., 4702 Grand Avenue, has approved plans for new steam-electric power plant for service at factory. Cost close ot $40,000, with equipment. Frederick C. Perry, Alworth Building, is consulting engineer.

Minn., Hibbing—City Council is planning installation of new turbo-generator unit in municipal electric light and power plant, with auxiliary equipment. Cost about $90,000. Financing will be arranged through Federal aid. Burlingame & Hitchcock, Sexton Building, Minneapolis, Minn., are consulting engineers.

Minn., St. Paul—Twin City Lumber & Shingle Co., Midway district, plans installation of electric power equipment in connection with proposed rebuilding of portion of mill, recently destroyed by fire. Loss over $85,000, including machinery.

Minn., Thief River Falls — Common Council is planning installation of additional equipment in municipal electric light and power plant, for increased capacity. Cost about $60,000. Proposed to arrange financing soon. P. G. Pederson is city clerk.

Mo., Leeds — Chevrolet Motor Co., 3044 West Grand Boulevard, Detroit, Mich., plans installation of electric power equipment in new one-story motor parts and distributing plant at Leeds, for which superstructure will soon begin. It will be 175 x 350 ft. Cost about $125,000. Albert Kahn, Inc., New Center Building, Detroit, is architect.

N. M., Zuni—Office of Indian Affairs, Department of Interior, Washington, D. C., plans new electric power plant at Zuni Indian Agency. An appropriation of $30,000 has been arranged. It is proposed to ask bids soon.

N. C., Charlotte—Chevrolet Motor Co., 3044 West Grand Boulevard, Detroit, Mich., plans installation of electric power equipment in new one-story motor parts and distributing plant on Hutchinson Avenue, Charlotte. Entire project will cost over $150,000. Albert Kahn, Inc., New Center Building, Detroit, is architect.

Ohio, Dover—City Council has secured fund of $330,000 through Federal aid for extensions and improvements in municipal electric light and power plant, to include installation of new turbine unit, high-pressure boilers, stokers, switchgear and accessory equipment. Proposed to begin work soon. Waldo Harline is city engineer, in charge.

Tenn, Chattanooga — United States Pipe & Foundry Co., Burlington, N. J., plans installation of power equipment, conveyors and other mechanical equipment in connection with expansion and improvements in branch plant at Chattanooga. Entire project will cost in excess of $200,000.

Texas, Liberty—City Council has secured loan and grant of $95,200 from PWA for new municipal electric light and power plant, and will have plans drawn at once. Installation will include three 150-kw. generator units and accessory equipment. Bids will be asked soon. Garrett Engineering Co., Houston, Tex., is consulting engineer.

Texas, McAllen—Rado Refining Co., recently acquired by new interests, headed by Ralph Fair, plans installation of power equipment in connection with proposed expansion to double present capacity. Also will install pumping machinery and accessories, tanks, etc. Entire project is reported to cost over $70,000.

Utah, Salt Lake City—Reilley Brewing Co., C. H. Reilley, 1221 East Seventh Street, president, plans installation of electric power equipment in proposed new multi-story brewing plant at 1010 South Main Street. Entire project is reported to cost about $200,000.

Wash., Port Orchard—Silver Springs Brewing Co., Bay Street, lately succeeding to plant and business of Kitsap Brewing Association, plans installation of electric power equipment in connection with extensions and improvemets in brewery, icluding new mechanical bottling works. Cost about $55,000.

Wash., Seattle—Seattle Brewing & Malting Co., recently organized to consolidate Century Brewing Association, Seattle, and Rainier Brewing Co., San Francisco, Calif., plans installation of electric power equipment in connection with proposed expansion at first noted plant. Cost over $175,000. Emil G. Sick, formerly head of Century organization, is president of new company.

Wash., Yakima—A. B. Thisius, 614 South First Street, has plans for new three-story cold storage and refrigerating plant, 100 x 125 ft. Cost about $40,000, with equipment..

Wis., Eau Claire—Wisconsin Steam Corporation, Sidney P. Hall, 335 McKinley Avenue, vice-president and general manager, will soon take bids for proposed new steam power plant on Dewey Street, fronting on the Eau Claire River, to be used for central heating service. Cost estimated at $200,000, with equipment.

Wis., Merrillan—Village Council has plans nearing completion for new municipal hydroelectric power plant. Financing will be arranged through Federal aid. W. S. Woods, 304 Main Street, La Crosse, Wis., is consulting engineer.

Wis., Oshkosh—Wisconsin Axle Co., 571 High Street, plans installation of electric power equipment in new one-story plant addition, 30 x 135 ft. Superstructure will be placed under way soon. Cost over $35,000.